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A Monthly Popular Journal of Knowledge

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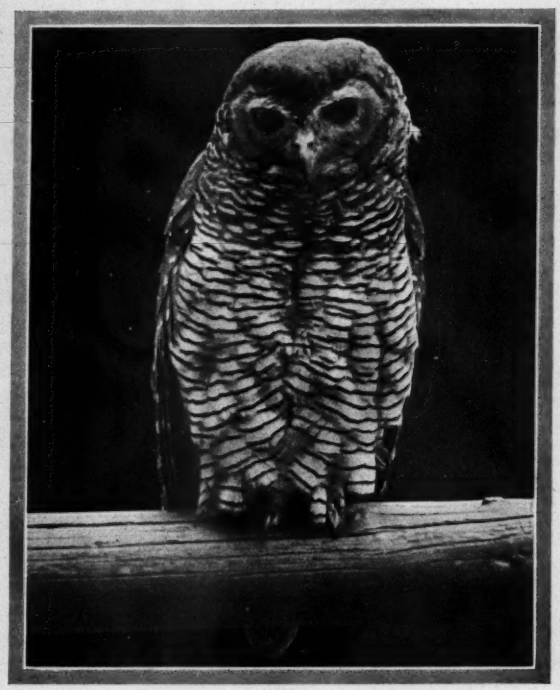

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Editorial Notes.

The lay press is grievously perturbed because it has been suggested that German scientists should be admitted on equal terms with other foreign scientists at the next meeting of the British Association. To make matters worse, the Prince of Wales will be President, and would therefore be a party to this dreadful reception of a handful of Teutonic scientists. In point of fact, the whole matter of the re-admission of the Germans is still under discussion by the authorities concerned, and decision on this matter will be reached later. At the Southampton meeting the point was unofficially talked about by a great many members and, judging from general indications, there was a distinct majority opinion in favour of their re-admission. This opinion was not founded on sentiment or politics, but was soundly based on logical facts. Freedom of scientific international intercourse is frankly indispensable. We may not realize it in particularized branches of science, but in matters appertaining to science as a whole it is a perfect nuisance if we cannot establish international co-operation. There are matters connected with astronomy and geophysics which require international co-ordination. Important developments of all kinds are hung up because Germany is still, so to speak, in solitary confinement. Quite apart from this important aspect, it is open to question if we are inflicting any punishment on Germany by maintaining the taboo. If anything or anybody is suffering it appears to be scientific progress in general. In other departments of national life the German has been re-admitted. German goods have been re-admitted, and the individual German is as free to travel here or in France as we are. Seven years isolation is a good long sentence, and there is little doubt that the whole question of continuing the present policy needs revision and modification to suit the more temperate opinion of the present day.

* * * * *

The scope of science is almost terrifying. At one end of the scale we have astro-physicists thinking in magnitudes beyond our ordinary powers of conception, at the other end physicists probing the inconceivably small matters which are slowly revealing something of the internal structure of the atom. Both these extremes are rather remote from the interests of common life. Interest in science in so far as the average layman is concerned, centres in scientific developments which may affect him. He knows vaguely about the atom, but he has a rather clearer idea of the recent Gye-Barnard work which has enabled us to photograph the ultra-microscopic virus associated with cancer. We may in not too long a space of time hear more about research in this department. During his lecture at Southampton, Mr. Barnard indicated some of the steps which were being taken in order to develop a new microscope which could be operated in a vacuum and enable photographs to be taken with the very short wave-lengths associated with the Schuman band of rays. These should reveal on the photographic plate not only the ultra-microscopic organisms, but detail of their structure. In large affairs, perhaps Dr. Arthur L. Day's researches on volcanoes can be taken as dealing with a big mass of material. He is the Director of the Geophysical Laboratory of the Carnegie Institute, and has been studying volcanoes for years. The results of his researches and the observations of co-workers are rather comforting, for they eliminate the old and still widely held idea that volcanoes are, so to speak,

safety valves communicating with a red hot molten interior to our globe. Investigation shows that lava is cooler below the surface and that all indications show that there is no ground for believing that a volcano has a generally molten interior. The investigations were made not only by forcing iron pipes down below the surface lava, but also at the crater of Lassen Peak in California. This obliging volcano emptied all its lava content and left a nicely opened clear crater ready for examination after the explosion. It was then found that fresh hot lava flowed in from side tubes or pockets above the level of the floor of the crater. The cross section of a volcano does not appear to be the old safety valve concept of the earlier geologists, or even the later theory of a molten layer concentric with the crust of the earth. It is more like a central collecting tube from which branch out feeders leading to local chambers where lava is being made. This brings us to the problem of what is responsible for the volcanic activity.

* * * * *

Professor Day's explanation is that it is due to water. A solution of silica and potash when heated under pressure in a laboratory can take up as much as 12·5 per cent. of water in solution. A rock magma in the earth is just such a solution, and can carry five to six per cent. of water. As the magma below crystallizes into rock it frees a large proportion of this water. If this happens in a closed space immense pressures may develop and the eruption of a volcano is nothing more nor less than the explosive liberation of the gases. As successive masses of material with gas under terrific pressures dissolved in it come nearer to the mouth of the volcano, they feel the release of pressure and burst. If these gases are, as in most cases, mainly steam, most of the discharge is volcanic dust in steam clouds and pieces of material projected by the blast. If the gases released by the magma are chemically active ones, such as chlorine sulphur or hydrogen, then greater activity is produced as these combine with the magma or the oxygen of the atmosphere, and poison clouds and fiery lava flows are produced. Volcanic activity appears to be declining, and few outbursts of recent times have yielded as much as a square mile of lava flow. The conclusion is that our volcanoes are local and superficial affairs representing belated geological transactions. They are simply outlets for a mass of magma in the last stages of crystallization. Of this little remains fluid except a few scattered pockets of geologically small dimensions. It is a comforting thought that these will work themselves out in time. But here we must pause, for if we are to believe another school of scientific thought there is a mass of radio-active material in the earth which will in due course generate enough heat to liquify more rock magma and cause enormous cataclysms. No exact date has been set for this event, it is still believed to be about to happen some hundreds of thousands of years from now. This gives us plenty of time to work out a new theory rejecting the uncomfortable ideas of the radio-activist school.

* * * * *

Superstition dies hard, but even with the activities of Sir Arthur Conan Doyle to fan the publicity of our modern necromancers, it is surprising to find that serious alchemy still flourishes in France. Jealous of Professor Miethe and his mercury lamp, the followers of Rosicrucian doctrine who comprise the Society of Alchemists of France have recently published a recipe for turning silver into silver alloyed with a small but assayable proportion of gold. The recipe is simple. One hundred and twenty-five parts of chemically pure silver are melted in a clean crucible. To this is added seven parts of yellow orpiment (arsenic tri-sulphide) and three parts of antimony sulphide. This is fused together for about four hours at 1,000 degrees Centigrade and produces a yellowish coloured ingot. The latter is again melted, and ten parts of orpiment and five parts of antimony are again added, little by little, to the pot. It is kept at the same temperature as before for a further four hours. Then comes the last process of fluxing the ingot. Ten parts of saltpetre and the same amounts of sal-ammoniac and borax mixed with a paste of scraped white soap are added to the crucible. This cleans the molten metal, which again changes colour from gold to white. It is then poured out and cooled. The operators claim that the mass now consists of silver alloyed with a small proportion of gold. Analysis and assay estimates indicate that the gold content is about one quarter per cent. of the silver employed. Several people claim to have attained this result, but orthodox science remains sceptical, although it is suggested purely as speculative theory that as the sum of the atomic weights of arsenic and antimony is 196·7, and gold is 197·2, it is possible that if impurities and deception are ruled out silver may act as catalyst and a small quantity of an isotope of gold has been produced. Alchemy as a survival in this century is entertaining, but unless the result is confirmed by independent scientific experiment, there is little reason to take the claim seriously.

The Cave Dwellers of Creswell Crags. A Record of Recent Excavations.

By A. Leslie Armstrong, M.C., F.S.A.

The Creswell Caves have again yielded valuable material. This account of the recent work gives an excellent idea of the manner in which the successive layers are excavated and the careful sieving necessary to ensure that no minute piece of evidence is lost.

MUCH of the work accomplished this season has been in the interior of the Pin Hole, a lofty but narrow fissure cave facing south and having a wide funnel-shaped entrance, fronted by a narrow platform. Being situated well up the face of the cliff, it would be easily defended, though not difficult to approach, and the contents prove it to have been a favoured retreat of both man and carnivorous animals throughout the ages.

It was in this cave that the Rev. J. M. Mello first discovered the bones and teeth of animals extinct in Britain which led ultimately to the exploration of the Creswell Caves by himself and Professor, now Sir William, Boyd Dawkins from 1874 to 1879. Until recently Mello was credited with having dug out the whole of the Pin Hole Cave, but suspicions were aroused that perhaps this was not the case when in September last a young Creswell miner brought to the writer, digging at Mother Grundy's Parlour, a number of fossil bones, including the complete tibia of a bison, and teeth of bear and hyæna. Inspired by watching the Parlour excavations he had tried his 'prentice hand upon the interior of the Pin Hole, with these gratifying results. Amongst the bones split fragments were present suggestive of man's handiwork, one of them bearing evidence of scorching by fire—a significant sign. A trial section revealed undisturbed ground and tools of flint, made by man. As this was in the dark interior of the cave, twenty yards from the entrance, it was a most promising indication and showed that much of the cave remained virgin; therefore, when in November the weather became unsuitable for outdoor work, attention was transferred to the Pin Hole and a systematic exploration commenced.

His Grace the Duke of Portland, whose interest in the Creswell work has from its inception been of the most practical kind, had already caused the cave to be made secure against intruders, and the Trustees of the Sladen Memorial Fund had provided funds for equipment and labour.

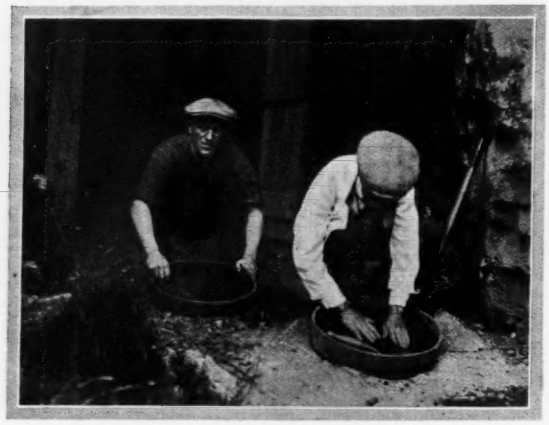
A Trial Section.

A careful survey showed the cave to be upwards of sixty yards in length. Of course, the first thing to do was to locate the point at which Mello's excavations had terminated, of which there was no surface indication. A trial trench from the entrance inwards revealed disturbed ground, though a few animal bones and teeth were present. Finally, at twenty-three feet, Mello's terminal face was found capped by a layer of unbroken stalagmite, itself buried beneath a foot of compact black earth and stones, of comparatively recent accumulation, in which was embedded a massive boulder of limestone weighing probably a quarter of a ton. Others, equally ponderous, blocked the passage beyond, their rounded backs and rugged angles smoothed by contact with many feet and hands, their surfaces scored with initials, arrow pierced hearts, lover's knots and similar vain efforts of modern cave "artists" to secure immortality.

Bone Fragments.

At this point the width is only seven feet, consequently these rocks presented a formidable obstacle, but we have to thank them for the preservation of the underlying deposits, and their presence seems to have caused Mello to abandon his work. Beneath the stalagmite was a layer of red cave-earth, full of angular fragments of limestone of all sizes. The cave-earth is a clean sandy material which passes freely through the sieve, and it was soon evident that it would prove rich in relics of both man and the giant carnivoræ and their prey. A canine tooth of wolf was the first find, its condition sound and perfect, its detection easy because of the enamel gleaming amidst the red sand and looking as fresh as if lost but yesterday and not fifteen to twenty thousand years ago. This was followed quickly by the canine of a veteran hyæna, worn flat at the tip and the enamel stained a dark brown, which was soon joined by a great molar of a powerful young animal with razor-like cutting edges and long, sound, fangs.

Splinters of bone, remnants of innumerable hyæna feasts, were present in abundance and formed 40 per cent. of the residue in every sieve full of earth.



SIEVING THE CAVE-EARTH.
G. A. Garfitt and the labourer.

Fragments of reindeer antler were numerous, there were teeth of fox and horse, pieces of bone gnawed by the hyænas and a strange ball-like object which, when partially cleaned, resembled a half-open rosebud, but proved to be the milk molar of a woolly rhinoceros, the owner of which, like the reindeer, horse and other animals, had fallen a victim to the fierce, cannibal, cave hyæna. Finally, at a depth of two feet, two long narrow blades of flint were uncovered, knives used by primitive man, and clear proof of his presence in the cave during the reindeer period.

A Relic Bed Ten Feet Thick.

The layer of cave earth proved to be three feet in thickness and to rest upon a lower layer of yellowish earth, much finer and more compact. The junction between the two is definable not only by the colour, but also by the presence of a jumbled stratum of limestone slabs, fallen from the fissure above, and which must mark a severe phase in the climatic history of Creswell. Subsequently this lower cave-earth was found to be five feet in thickness, and the total depth of stratified deposits to average ten feet; the lower layer proving richer in animal remains than the red upper layer, relics of man occurring freely in both.

Having located the presence of these undisturbed deposits I decided to examine the cave in a series of sections, as nearly eight feet in length as the position of the surface boulders would permit, and to barrow the resulting spoil from the first section to the exterior of the cave. Afterwards, in succeeding sections, disposing of it by packing rock and debris in the rear as the excavation proceeded. This method has proved both effective and economical.

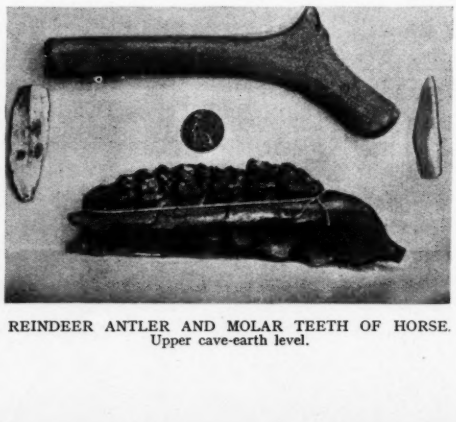
The preliminaries in a dig always demand considerable time, but to secure results of scientific value are absolutely imperative; therefore, before disturbing the existing surface, the line of the cave floor was carefully traced in white upon the walls, also white vertical lines a foot apart, denoting the distance in feet from the datum point, to enable accurate records to be kept of the exact position of all the objects found in the course of the dig, and the objects themselves to be marked with the corresponding letters and figures.

Removing Obstacles.

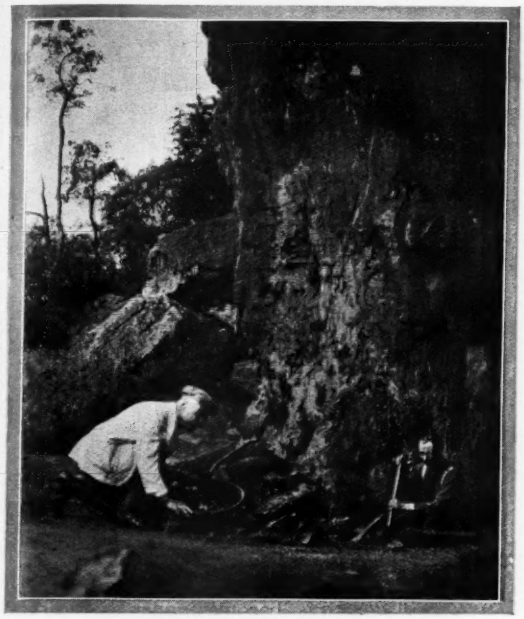
The removal of the great boulders occupying the floor was the next procedure, the first of which presented the most difficulty. After a prolonged argument, sustained chiefly by the labourer, a skilled miner, punctuated by crow-bars and emphasised effectively with a 7 lb. hammer, it was finally persuaded to vacate the site bearing severe marks of the encounter, and to leave the floor at our disposal.

The surface earth varies in thickness from six to eighteen inches according to position, and in consistency from soft putty to a hard compact clay requiring a hammer and patience to break it up and examine it. The labour has been considerable and the scientific value of the finds small—so far. Collar studs, buttons, and pipe stems have been numerous, glass superabundant, flint almost entirely absent, ancient pottery rare, but one small piece of bronze has rewarded the careful examination of Mr. G. A. Garfitt, F.S.A. and my son, who have recently dealt with the major portion of this unpleasant material.

Two complete sections, " A " and " B " have been examined to a depth of ten feet average, and a third section, " C," is now in progress. Over the whole of this area extended either a layer of stalagmite, very difficult to break up, or a breccia, resembling lime concrete, more easily dealt with. In both materials bones and flint implements were frequently enclosed. The most astonishing feature of the cave-earth is the



REINDEER ANTLER AND MOLAR TEETH OF HORSE.
Upper cave-earth level.



PROSPECTING A LIKELY ROCK-SHELTER.
G. A. Garfitt and A. L. Armstrong.

preservation of the contained animal remains. Teeth are in perfect condition, and in appearance might have been extracted yesterday.

Bones are hard and so fresh-looking that side by side they are scarcely distinguishable from recent specimens. This is particularly striking in the case of the fine hair-like wing bones of the bat, bird remains and those of the lemming and other small rodents.

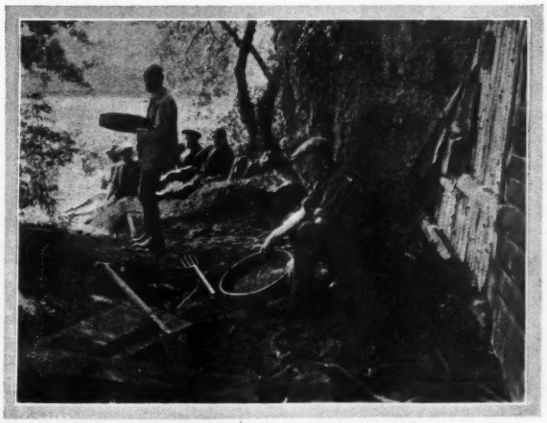
Perfect Preservation.

Even skulls of small birds and tiny mammals, thinner than parchment, are perfectly preserved, also jaws and vertebræ of fish, including the voracious pike with its formidable array of needle-like teeth. The preservation of the larger animal bones is equally good, but these rarely remain untouched by the hyænas. A few have been found in perfect condition, others are split by man and charred by roasting prior to the extraction of the marrow, and frequently these show cuts and scratches caused by flint knives in defleshing the bones. The limb bones of the woolly rhinoceros seem to have been a dainty much beloved by the hyæna; possibly because the interior is solid, though spongy. The portions left are always extensively gnawed and deep cavities have been licked out at either end to obtain this succulent material. The popular belief, however, that hyænas devour the bone entirely and leave no trace, is proved to be mythical by the abundance of splinters and fragments found in every sieve full of earth. Several of the large partially gnawed bones were found in positions which suggested they had perhaps been hidden there by the animals and forgotten, just as a well-fed dog will hide a bone for a future meal. Others, which had been roasted and split by the cave-men and thrown aside, had afterwards been gnawed by large carnivoræ; an interesting fact telling us clearly that man was but a casual occupant of the cave, and that the permanent residents were the hyæna, wolf, and bear, with whom he must have contended for its possession. Exclusive of small mammals, fourteen distinct species of animals are represented in the upper cave-earth, including reindeer, mammoth and woolly rhinoceros, which indicate a sub-arctic climate.

Reindeer is very abundant and, together with horse, seems to have formed the staple food of the cave-men, who no doubt followed the animals in their seasonal migrations. The flint implements and tools recovered from the upper cave-earth, though fewer than those obtained at Mother Grundy's Parlour, are numerous and important and represent three distinct periods of occupation.

A Thrilling Find.

At a depth of one foot beneath the stalagmite in the second section explored was found the greatest treasure so far obtained at Creswell. When my fork uncovered this object its appearance was not exciting, it merely resembled the shaft of an ordinary small bone but, upon removing its mantle of cave-earth, engraving was visible, and it was seen to be a beautiful lance point, made of mammoth ivory, bearing an engraved pattern in interlacing lines upon one side. In diameter it is similar to a lead pencil and about



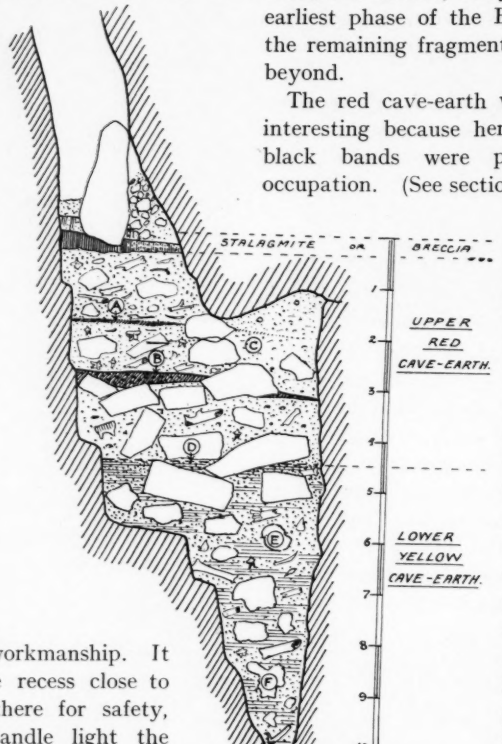
TREASURE HUNTING AT MOTHER GRUNDY'S PARLOUR.

half its length, the end prepared for attachment to the shaft shaped like a screwdriver with the slanting surfaces scored across to improve the grip, from which feature this type of lance is termed " double bevelled." This was a thrilling find, and is an outstanding one, as no example has previously been found in this country, and the Creswell specimen proves to be identical with one from the classic Magdalenian site, the cave of La Madeleine, in France. That it is Magdalenian in design and technique is unquestionable, and, being found in actual association with flint implements of precisely the same pattern as those from the lowest level of Mother Grundy's Parlour, it provides invaluable evidence for dating the two sites and correlating the Creswell culture with the French cave cultures in regard to time.

Relics.

Another interesting find was a perforated shell bead hidden away in a crevice beneath a projection of the cave wall (" C " on the section). This is of a type frequently found with Aurignacian interments. A foot deeper, under the same projection, was a beautiful oval knife of flint, termed a " point," of Proto Solutrean workmanship. It was lying at the back of the recess close to the wall, as though placed there for safety, and gleaming white in the candle light the smooth ivory patina made it a striking object amidst the dull red cave-earth. This treasure turned up at the close of a strenuous but almost unproductive day's dig, a way which these prizes have. It was ample recompense, however, for it established beyond doubt the presence of Solutrean influences.

Near the base of the upper cave-earth is a layer sterile of human relics and then, at the bottom, rudely chipped Mousterian tools, of quartzite, occur (" D " on the section). Here a bone " anvil " was found, part of a rhinoceros tibia, one face bruised and chopped into a deep concavity, probably the result of splitting bones or preparing food. This object, as the large bones frequently do, so closely resembled a stone that it was unrecognisable until the difference in weight revealed its nature.



TYPICAL SECTION OF SECTION " C " IN THE PIN HOLE.
(*a* and *b*) Black bands and hearths; (*c*) The rodent corner; (*d*) Upper Mousterian level; (*e*) Lower Mousterian level; (*f*) Lower Palæolithic level.

Progress in July.

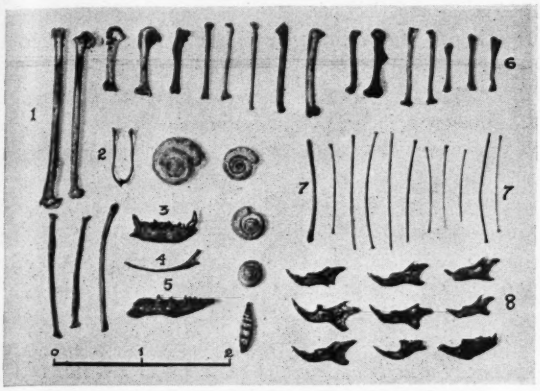
Five days at the end of July have been devoted to the upper cave-earth in section " C " between thirty-six and forty-two feet from the datum, where the cave narrows abruptly, becoming a passage barely two feet wide.

Recent accumulations forming the floor were eighteen inches thick and considerably disturbed, but contained part of a decorated vessel of earthenware, termed a beaker, a type generally assigned to the earliest phase of the Bronze Age. It is hoped that the remaining fragments will be found in the section beyond.

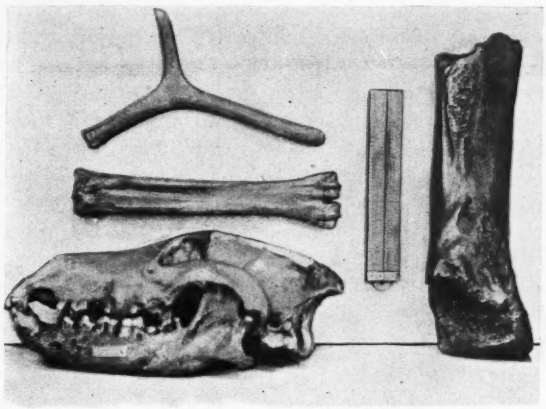
The red cave-earth was intact and proved deeply interesting because here, for the first time, definite black bands were present indicative of man's occupation. (See section.)

Charcoal was very abundant, and in each layer large hearths occupied the centre of the passage. Though this becomes wider as the section is dug deeper, its width at the lowest black band is under four feet, but further on it again opens out into a large inner chamber proved by a trial hole to have been occupied by the cave-dwellers. Having regard to the abundance of charcoal at the passage entrance and its scarcity elsewhere, it is reasonable to infer that fires were lighted in this restricted position for protection. When the inner chamber was in use they would effectually prevent the return of wild beasts who usually occupied it, or possibly prevent the exit of those already inside when the encampment was made in the outer chamber.

One does not anticipate finding many relics in an actual fire zone, but nevertheless a few flint tools were present, including a large burin, or graver, and a superb Proto Solutrean knife of unusual size which must surely have been left there by an absent-minded cave-man. This section has been rich in small mammalian remains due to the presence of a shallow recess—which we have termed "rodent corner" (" C " on the section). This is formed by an abrupt



BONES FROM THE RODENT CORNER, PIN HOLE CAVE.
1 and 2. Bird bones. 3. Polecat jaw. 4 and 5. Fish jaws. 6. Small mammal bones. 7. Bats wing bones. 8. Jaws of small rodents.



[REINDEER ANTLER AND BONE. WOLF'S SKULL. FEMUR] OF WOOLLY RHINOCEROS GNAWED BY HYÆNAS.
All from upper cave-earth.

projection of the cave wall, only a few inches above the lowest black band. In the lower cave-earth levels this will become the cave roof, but at the level under examination it formed an ideal retreat for rodents whose remains are present in great abundance. The earth is very fine and dry and as the tiny bones of these creatures pass freely through the sieve, they are difficult to detect and retrieve; work in which Mr. Garfitt excels.

Advantage has been taken of the fine weather to continue the excavations at Mother Grundy's Parlour and to examine a series of promising rock shelters. The latter have proved disappointing, but the Parlour site continues to yield a harvest of flint implements, though they are less plentiful than in the area examined last year. The most important finds have been implements from the Azilio Tardenoisian level and from the extreme base of the section.

Past Climates and Continental Drift

By Julian Huxley.

The Wegener theory is one of the most important new ideas in geophysics. This article-review summarizes some of the more interesting matter in Wegener's latest book.

WEGENER is well known for his startling theory, launched a few years ago, concerning the movement of the continents over the surface of the earth. He now comes forward with a collaborator, to give us a book which is in part an amplification of his old theory (with new evidence and from a different angle), and in part an attack upon a new problem, namely, that of past climates.

Experts Disagree.

It would be impossible to give, in a brief article, a real criticism which would be of any value. The theory is based upon a great number of lines of evidence, in each of which the experts must have their say before we can feel sure of our ground; and, as regards the idea of continental movement, the experts are still in total disagreement among themselves. Probably the final incorporation of the theory into the body of scientific principle, or its final rejection, will be delayed until time enough has elapsed for a perfectly definite answer to be given, by means of accurate determinations of longitude, to the question whether or no the continents are actually shifting position relative to each other; and that will not be for some decades.

Meanwhile the best the reviewer can do is perhaps to give some account of the problems at issue, to interest the general public, and to show what remarkable problems are now agitating the sciences of geology and geography.

Original Theory.

Wegener's original thesis, in briefest space, was this—that the continents, though essentially permanent as continental masses, as blocks of land most of whose surface projected above sea-level, are not fixed in position, but are slowly though continuously drifting from place to place under tidal influences. Some masses are more firmly anchored than others, so that

there may be relative motion between different continents. Wegener maintains that the American continent is now drifting westward, relative to the great land mass of Europe, Asia, and Africa, at the rate of a yard or so a year; that it was once, in times not so geologically remote, continuous with that land-mass; and that it split off along a crack now represented by the margins of the continental shelf on either side of the Atlantic—in witness of which he points out that a great part of these two margins will even to-day, in spite of all the deformation which they have presumably undergone, fit into each other, as you may see by a look in the atlas at the west coast of S. America and the east coast of Africa.

Zoological Interchange.

He supposes further that the continents are composed of materials essentially different from the deeper mass or magma below; they are the crust of surface slag into which, during the long processes of earth cooling, certain types of elements have become segregated according to natural laws. Over the deep oceans there is now no crust, the naked magma here coming to the surface; and the blocks of crust float in the magma like icebergs in the sea or, to use a simile which takes a little more account of the viscidity of the magma, like pieces of toast in a lake of treacle.

Tidal friction is always tending to move the crustal masses westward; hence the fact that great mountain ranges are usually found upon the western sides of continents, near the sea—the crumplings of the crust as it ploughs its westward way. Further, when lines of weakness develop in a big piece of crust, then if the eastern side is better anchored, the western part will tend to split off and start life as an independent continent. Wegener believes that the Red Sea and the Great Rift Valley of Africa are such incipient splits.

Many important consequences would flow from the acceptance of such a theory. In the first place, the zoologist would be relieved of much embarrassment in accounting for various facts of geographical distribution. For instance, there can be very little doubt that Australia was at one time able to interchange land animals with South America via the Antarctic continent. But to have done this, land bridges would be necessary, and the one from Australia to Antarctica would, on the present distribution of land and sea, have to have existed across a deep ocean—a hypothetical construction which almost all geologists refuse to allow us. If, however, Wegener is correct, then Australia was in the past actually connected with Antarctica, and has since drifted away (incidentally, according to our author, shoving its nose into various chains of islands and deforming them with the momentum of its progress), carrying into isolation its menagerie of primitive animals free to develop without competition from later products of evolution. Then again, it would at least help us to understand that most puzzling fact of the apparent changes of climate which have overtaken various parts of the world's land-surface. The most familiar example is the existence, in lands at present Arctic, with no vegetation above a few inches in height, of coal beds testifying through their contained fossils to the past existence of tropical or semi-tropical warmth and abundant forest trees. The Spitsbergen region, to take but one instance, has experienced no fewer than four separate coal-forming periods. Wegener supposes that the position of the continents relative to the poles has changed, partly through their own wanderings, partly perhaps through an alteration of the polar axis itself, which would be consequent upon the upset of the earth's equilibrium caused by the continents' wanderings. This would make it possible for one and the same country to have passed through all the extremes of climate during its long history.

A consequence of this idea would be that the general climatic zones with which we are familiar—arctic, temperate, and tropical—must have always existed, but that they may in the past have occupied quite different positions from their present ones. Accordingly, Wegener seeks in the first half of the present volume to add new support to his old theory, as well as helping on the development of the infant science of past climates, by putting together all the evidence bearing upon this problem of the existence of climatic zones in past epochs of the earth's history.

Reconstructions of the Past.

The evidence which is available consists, of course, chiefly of stratified deposits, and also of the familiar evidences of ice action.

Ice action testifies to an Arctic zone; coal and similar deposits to a tropical or semi-tropical climate, and deserts and deposits of salt and gypsum to the past existence of dry bands, similar to those which now girdle the globe between the tropics and the true temperate regions.

Wegener gives a number of reconstructions of the appearances of the continents in past ages, based upon a combination of his theory of continental drift and of the evidence from past climatic zones. These are interesting, but it must be confessed that they are not always convincing. Sometimes fossil

finds which would upset his zoning are rejected on insufficient grounds, sometimes some of the zones as depicted in the figures are too close to or too far from the poles to give one much confidence. Again, however, the idea is a new one, and will bear fruit, though time alone will decide whether it is correct.

One of the most fruitful applications of Wegener's ideas has been to the hypothesis, erected by botanists to explain certain facts of the distribution of plants in the past, of the existence up to Mesozoic times of a continent, dignified by the name of Gondwanaland, connecting S. Africa, S. America, the Falklands, Antarctica (Scott found the characteristic fossil plants up to 85°S.), Southern India, and Australia. It is extremely hard, on known geophysical principles, to explain how the major part of such a vast continental mass could disappear and its place be taken by deep ocean.

No Gondwanaland.

Further, traces of glaciation dating from the end of the Paleozoic period have been found in nearly all these regions. If the ice had covered all the countries as they now lie, together with the intervening region, it would have constituted a glaciation of unparalleled extent, covering the better part of a hemisphere. But this very real difficulty would be overcome if we suppose, with Wegener, that no continental mass has sunk beneath the sea, but that the hypothetical Gondwanaland consisted solely of those parts of the existing continents where the typical fossils are found—which, however, were then still joined together into a single land-mass.

Over a third of the book is devoted to a detailed and interesting study of the climate of the quaternary or recent period, from the onset of the " ice-age " until the present. A considerable body of evidence from various sources is analysed which goes to show that the successive glacial periods did not all emanate from the same centre, but that this centre moved gradually from the west to the east side of the north coast of the American continent to central Greenland, and then northwards. In other words, there is again evidence of what Wegener calls " pole-wandering," a movement of the land-masses and the poles relative to each other. According to Wegener, the earliest glaciation of Alaska took place before that of the United States, and that again before the earliest European glaciation.

An important discussion, which we can only mention here, is given of the astronomical causes of the alternation of glacial and inter-glacial periods, together with a table showing the variation in the total amount of solar radiation received by the northern and southern hemispheres respectively during the last 650,000 years. This variation is due to variations in the ecliptic—the angle made by the plane of the equator with the plane of the earth's elliptic course round the sun—and in the eccentricity of this elliptic course itself. Sometimes the two sets of variations reinforce each other in their effect upon the amount of the sun's radiation, sometimes they tend to cancel out.

The whole matter is susceptible of mathematical calculation. and this has been performed by Professor Milankovitch, of Belgrade, from whose results the table is constructed.

A remarkable coincidence is found between the calculated times of low solar radiation and the actual times, so far as these have been estimated by geologists, of the various glacial periods. We are thus given a first glimpse of what should be one of the main goals of geology in the future—the establishment of an absolute chronology in terms of years, instead of a merely relative chronology in terms of periods whose relative length is guessed at by the thickness of their deposits, but of whose absolute length we have nothing but the most various speculative estimates.

Before concluding, however, I must refer to recent conclusions of Professor Joly,* since these may have important bearings on Wegener's hypothesis. Briefly, he points out that, owing to the radio-activity of the materials of which the central mass of our globe is composed, its internal temperature must gradually rise until the central mass liquefies. This will give the signal for great volcanic upheavals, together, of course, with cooling; and so great cycles or, as he styles them, revolutions, of alternate accumulation and liberation of heat, alternate quiet and volcanic activity, alternate solidity and fluidity of an interior layer of basalt, will constantly recur in the earth's history.

Volcanic Cycles.

The specific gravity of the basalt on which the continents float alters on the passage from the solid to the fluid state; with such a change the floating continents must rise or fall, like icebergs passing from fresh to salt water; and so are explained the alternate floodings of the continental margins with sea and their risings-up once more into the air, which characterize geological history.

Further, Joly points out that solidification and contraction will produce crumplings of the earth's

(*Continued on page* 397).

* Radio-activity and the Surface History of the Earth, Oxford, 1924.

Die Klimate der Geologischen Vorzeit, Berlin, Borntraeger $2.50.

FIG. 2.
ROBERT CECIL
Afterwards first Earl of Salisbury.

that Mary's Scandal Letter to Elizabeth is partly responsible for this estimate of her character.

As soon as Mary realized that Elizabeth was merely deluding her with specious promises, she felt herself justified in adopting any measures to regain her liberty and her crown: and at first the Countess entered into the successive schemes and plots by which she tried to effect her purpose, but six years later an event occurred which led to first a coolness and then a breach between the two ladies.

Jealousy and Policy.

In 1574 the Countess succeeded in bringing about a marriage between Charles, the younger brother of Lord Darnley, and her daughter (by her third husband) Elizabeth Cavendish, and for this successful scheme she was sent to the Tower by Queen Elizabeth, but after a few months she was set free and rejoined her husband at Sheffield Castle.

In the following year the Lady Arabella Stuart, the "Arbela" of the Scandal Letter, was born, and her birth created another possible claimant to the English Crown, and made her grandmother, the Countess, no longer so eager to further Mary's cause, but, on the contrary, ready to plot against her. The estrangement thus begun was intensified by the Countess becoming jealous of the attention paid by her husband to Queen Mary, and she took her revenge by inflicting petty tyrannies on the Queen.

After several years of negotiations and disappointments, plots and counterplots, and increasing restrictions upon her liberty, Mary adopted an ingenious but malicious plan of revenging herself simultaneously upon the Countess and Queen Elizabeth for the slights that had been put upon her, and wrote a letter (or possibly two letters) to Elizabeth in which she related a string of scurrilous stories about the English Queen, for which, as she repeatedly pointed out, the Countess of Shrewsbury was responsible.

Obscure History.

The tradition attaching to this strange incident is curious. The letter begins abruptly, and refers to a previous letter on the same subject. In a history of England, written by Thomas Carte, "an Englishman," in 1752 (vol. III, p. 828), it is stated that Mary had been provoked into writing letters containing infamous calumnies to Elizabeth; that the Lord Treasurer, Burghley, took care to keep these letters from coming to Elizabeth's hands, but preserved them; and that they were afterwards buried two feet underground in his son's, the Earl of Salisbury's house at Hatfield; that they had been found a few years

FIG. 3.
LADY ARABELLA STUART.

Mary Stuart's Scandal Letter to Queen Elizabeth.

By C. Ainsworth Mitchell, M.A., F.I.C.

The author applying the latest scientific handwriting tests to the celebrated Scandal Letter concludes that, unlike the Casket Letters, it was written by Mary Queen of Scots.

MARY, Queen of Scots was a prolific letter writer. As she had the gift of expressing her thoughts readily on paper, and used it freely, it is possible for us to become more fully acquainted with her writing than with that of most of her contemporaries.

Of the large number of her letters that have been preserved, more than 140 were written to Queen Elizabeth, many of them after the abortive Conference at Hampton Court, where, to quote Sir James Melville ("Memoirs," p. 108), "the Queen of England having obtained her intent, received thereby great contentment through the advantage she thereby received."

FIG. 1.
ENLARGED MINIATURE OF QUEEN ELIZABETH.
Reproduced by kind permission of Mr. F. Chamberlin, who has proved it to be an authentic portrait.

Even then, Mary remained blind to the significance of the political move that had been made, and, as her letters plainly show, she still clung to the idea that Elizabeth would eventually help her to regain the Scottish Crown. The difficulties in the way of this, she persuaded herself, were not made by Elizabeth herself but by her agents, and could be smoothed away if Elizabeth would but grant her the interview for which she had begged from the first moment of her coming to England. But Elizabeth had no intention of risking by a meeting the advantage she had already gained by the balanced policy she had pursued. Her plan still was to keep Mary in doubt without driving

Elizabeth's Letters.

her to despair; and so she continued to send specious messages to her, promising that "not any part of the false accusation should be made known by her, or her council, to any: praying her to take patience in her gentle ward, where she was nearer to get the Crown of England set upon her head, in case of her decease who was but the eldest sister." (Melville, *loc. cit.*).

Then to give a suggestion of the absence of compulsion to Mary's retention in England, it was proposed that she should remain nominally Queen of Scotland, but live as a private person in England, and that her son should be associated with her as King, and that during his minority the Government of Scotland should be left in the hands of the Regent Murray (Goodall, ii, 295); but Mary, as was anticipated, indignantly rejected this proposal, saying that she would rather die than do so ("*Je suis resolve et deliberée plustot mourir, que de faire*"); that she would not lightly throw away what God had given her; and that she was determined to die a queen ("*Je me resolve de mourir Royne que femme privée*": Goodall, ii, 301-305).

The Prison.

On the pretext of bringing pressure upon Mary to agree to these terms, but really to remove her from Bolton, where she was in the midst of Catholics who were friendly to her and therefore likely to join in plots for her escape, it was decided that she should be taken to Tutbury Castle, in Staffordshire, and that no one should be allowed to see her or communicate with her without the knowledge of Elizabeth. (Goodall, ii, 296.)

The Earl of Shrewsbury was made responsible for her safe keeping, and so began the long intimacy between Mary and the notorious Countess of Shrewsbury, who was then in her 52nd year. This lady, who is familiarly known as "Bess of Hardwick," was the daughter of John Hardwick of Hardwick in Derbyshire. She was first married at the age of 14, and had already had two more husbands before becoming the wife of the sixth Earl of Shrewsbury, some two years before Mary was sent to Tutbury, and each succeeding widowhood had brought her large additions to the estates she had inherited.

Historians are agreed that she was a domineering, quarrelsome woman, an ambitious schemer, and a malicious scandalmonger, although it is probable

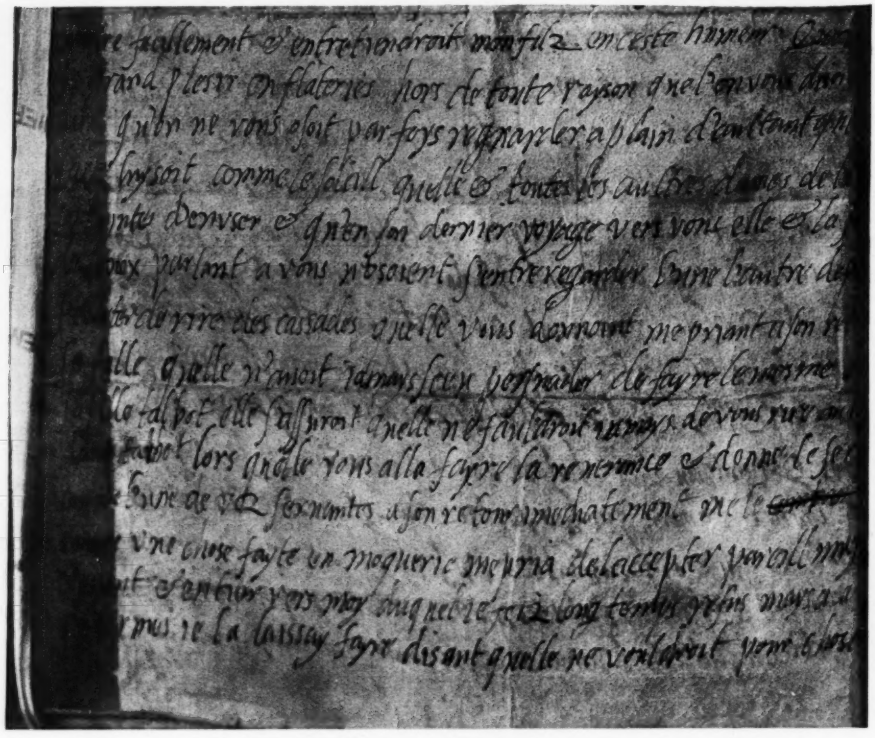


FIG. 4.
PART OF THE CELEBRATED "SCANDAL LETTER."
[*By kind permission of the Marquis of Salisbury.*

before in a stone chest rolled upon woollen; and that they were shown by the publisher of Burghley's papers to the Master of the Rolls and another reputable witness.

Murdin, writing 17 years later, states that he found this letter open among other papers of the Earl of Salisbury, and that he could not obtain any confirmation of Carte's story from the then Lord Salisbury's family. No other letter was forthcoming.

Variant Versions.

Hume gives a summary of the contents of the letter based on Murdin's version which had recently been published. He describes it as "impudent and malicious" and hazards the assertion that it angered Elizabeth so much as to lead to the extreme severity with which Mary was afterwards treated at her trial ("History of England," chap. xlii, p. 227). I have been unable to discover any evidence to support this suggestion of Hume.

The letter was afterwards printed in full by Labanoff (1842), who introduces the formal opening "Madame," which is not in the original, and Froude ("History of England," chap. xxxii, p. 101) gives a large portion of an inaccurate version, in which he not only omits certain passages without indicating the omission, but also introduces the formal "Madame," and interpolates the name of Leicester into the first charge against Elizabeth.

The Scandal Letter.

The original letter is still to be seen at Hatfield and is endorsed "Reade" on the back in handwriting attributed to Robert Cecil. One can hardly imagine that such a shrewd statesman as Robert Cecil, afterwards the first Earl of Salisbury, would have been so unwise as to let Queen Elizabeth see such a venomous effusion, and on the whole it seems probable that, as Carte states, the letter was never allowed to reach its intended victim.

This extraordinary document, which is written in French, fills four closely written pages, and is certainly written on a poorer quality of paper than is usual with Mary's letters.

It opens abruptly with a statement that Mary is writing in accordance with her promise and in answer to Elizabeth's request, that she is writing without any animus, and that she is giving in as nearly as possible the actual words the things told to her by the Countess of Shrewsbury. "But," she hastens to add, "I protest that I reproved the lady for saying such licentious things about you, which I did not, and do not now believe, being well aware of the Countess's disposition and of her feeling towards you

Mary then proceeds to give the various charges in detail. In the first place the Countess had told her that Elizabeth, after making a promise of marriage before one of the women of her bedchamber, had repeatedly shared the bedroom with a certain man. (Here Froude interpolates "Leicester," which is not in the original.) But that as Elizabeth was un-

doubtedly not as other women, those who were trying to bring about her marriage with the Duke of Anjou were foolish, since the thing was impossible, nor would Elizabeth be willing to lose her freedom to make advances to others.

Accusations.

The Countess regretted for the honour of her country, Mary continues, that the Queen was not content with Master Hatton and another Englishman, but must needs compromise herself with a foreigner named Simier*, to whom also she had revealed the secrets of the kingdom. As to this Hatton, she had made such a public parade of her love for him that he himself had been forced to draw back.

The Countess had laughed unrestrainedly while advising her (Mary) to enter her young son on the list of Elizabeth's lovers, and had added that Elizabeth was so vain of her beauty that she would not see anything ridiculous in such a proposal. That anyone could offer her the most extravagant flattery and that she (the Countess) had been unable to look at the late Countess of Lenox lest she should burst into laughter at the tricks she was playing on the Queen. And then the Countess's daughter had mimicked the ceremony when she was made an attendant to the Queen, and on her return from the Court had begged with tears that she might also make a curtsey and take the oath to her (Mary), which, after some hesitation, she had allowed. Lady Talbot had said that she would be afraid to be nearer Elizabeth, lest the Queen might break her finger as she had done that of her cousin Shedmur (Scudamore), making out that a candlestick had fallen upon it.

Moreover, says Mary, she had been warned by the Countess that Elizabeth had urged Rolson to make love to her (Mary) either to dishonour her or to get the reputation of having done so.

She had been told, too, that Elizabeth suffered from a malady of the leg and other complaints and so was likely to die soon, and that it had been predicted that another queen would succeed her, but that she (Mary) had always told the Countess that she looked upon this as pure folly, but that nevertheless the Countess had planned to be one of the first about her, and that Mary's son should marry the Countess's grand-daughter Arbela†.

After more details in the same strain, Mary again swears that she is speaking the truth, but that whatever affects the honour of Elizabeth she holds to be false and will never reveal. Finally the letter ends with a plausible reason for an interview. "If," says Mary, "I can but have the good fortune of speaking with you, I will tell you more in detail the names, times, places and other circumstances, in order to

*Agent of the Duke of Anjou.

†Arabella Stuart.

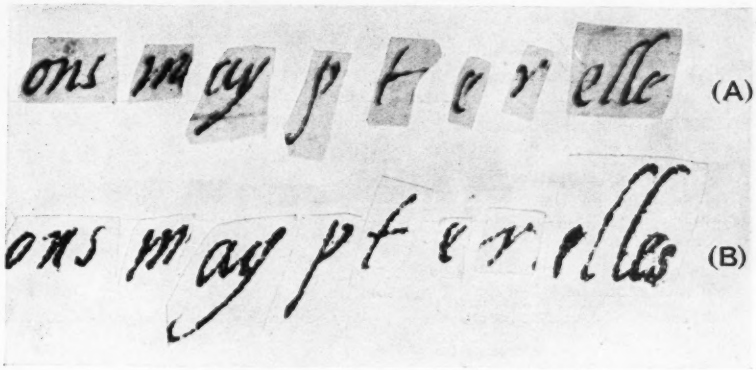


FIG. 6.
ENLARGED PHOTOGRAPHS OF LETTERS TAKEN AT RANDOM.
(*a*) The Scandal Letter; (*b*) Admitted Letter of Mary Stuart.

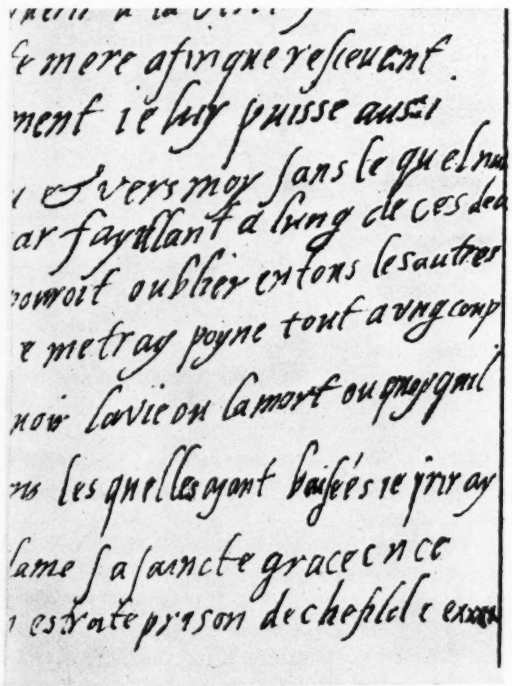


FIG. 5.
PORTION OF LETTER.
Admittedly written by Mary Stuart to Queen Elizabeth from her "prison of Sheffield."

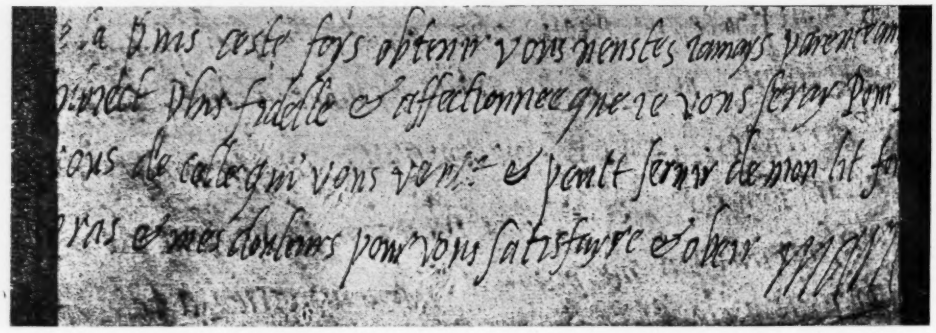


FIG. 7.
LAST LINES OF THE "SCANDAL LETTER"
Written by Mary to Elizabeth. Hatfield House.

let you know the truth about this and other matters, which I reserve until such time as I am sure of your friendship."

Interest in the contents of this letter has recently been revived by Mr. Frederick Chamberlin's very original work, "The Private Character of Queen Elizabeth." He discusses the charges there put forward and shows conclusively that even if there were no doubt as to the authenticity of the letter itself, those charges fall to the ground, since Mary herself expressly states that she does not believe those that affect Elizabeth's honour.

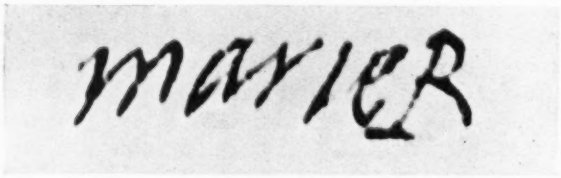


FIG. 8.
NORMAL SIGNATURE OF MARY QUEEN OF SCOTS.
Enlarged photograph of signature on a letter at Hatfield House.

Whilst Mr. Chamberlin admits the possibility that the letter may be genuine, he plainly shows that he doubts it. The reasons upon which he bases his doubts are firstly the style, secondly the poor character of the paper, and thirdly the absence of a formal opening and ending. In his opinion it would not be difficult to forge such a letter.

Balance of Probability.

In this case the handwriting is the criterion, and the arguments brought by Mr. Chamberlin are only speculative evidence, although they require comment. The question of the paper is not of much importance, unless it can be proved that Mary never wrote any letters on similar paper from Sheffield; nor can much weight be attached to the style of the French, since the subject is hardly capable of "elegant" treatment. Moreover, Hume and other historians dismissed the argument of style as of scant importance when applied to the "Casket Letters."

Mr. Chamberlin is correct in stating that Mary's admitted letters to Elizabeth all begin and end formally, but he is mistaken in his assertion that the absence of a formal address or ending "is unique, either separately or combined, in any letter left to us in Mary's hand," for there is another letter at Hatfield, written in the same year from Sheffield to Archibald Douglas, in which also there is no formal beginning.

To produce an imitation letter that might have satisfied the Commissioners who examined the "Casket Letters" is one thing; to forge a long letter such as this in such a way as to preserve all the less obvious characteristics of the writing is quite another thing.

Detail Analysis.

Apart from the minute resemblances in the formation of the letters both of the signature and of the text (see Fig. 7, 8 and 9), the quantitative ratios of parts of letters towards each other is also preserved. This method of examining handwriting, which was devised some twenty years ago by Persifor Fraser in America, and has been developed by Dr. Locard, Director of the Police Laboratory at Lyons, was described in outline in DISCOVERY on "Graphometry." The present writer has found that if it is not restricted to a too limited amount of material it undoubtedly affords evidence of the genuineness of a given piece of writing.

One of the quantitative relative measurements upon which Dr. Locard places great value depends upon the fact that the height of the letters in a word (omitting letters such as "p" or "d" which extend far above and below the line) increase or decrease in size from the beginning to the end of the particular word, and that this gradation tends to be a constant which can be expressed as a diagram. If the heights of each of the succeeding parts of letters are measured and connected by lines at the different heights, a curve will be obtained which tends to be reproduced in the

writing of the same person. If, for example, the parts of the letters in the words "mon Dieu" in the Scandal Letter and in the admitted writing of Mary Stuart are measured and plotted in curves, the form will be found to be closely similar (Fig. 9). This is only one of a large number of instances in which analogous agreement is to be found.

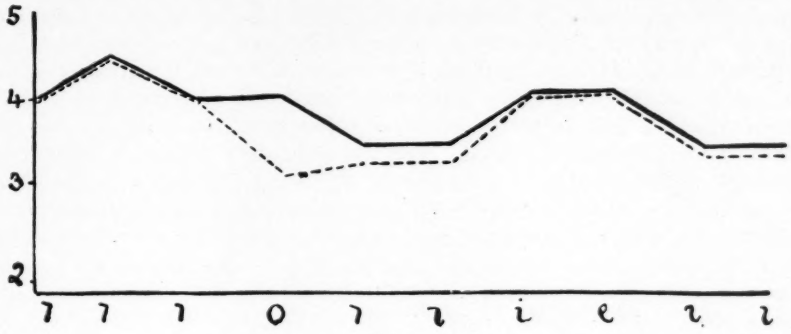


FIG. 9.
(*Block from "The Expert Witness." C. A. Mitchell.*)
DIAGRAM OF RELATIVE HEIGHTS OF PARTS OF LETTERS IN THE WORDS "MON DIEU."
Black line, Scandal Letter; Dotted line, Admitted Letter of Mary Stuart.

There can thus be little doubt that the letter is a genuine one. It is probable that in writing it Mary wished not only to create a definite breach between Elizabeth and the Countess of Shrewsbury, but also to sting the Queen into giving her the long-sought interview. If this was her aim it was not realized, for even if Elizabeth ever received the letter, which is improbable, she took no steps to learn more of what Mary was prepared to reveal; the two queens never met.

Past References.

Apart from the light that it throws upon the feelings of Mary towards Elizabeth at this time, the letter is also a significant indication of the social atmosphere in the Earl of Shrewsbury's household at Sheffield. It is not surprising that shortly after this time the Earl should have found his task so unbearable that he begged Queen Elizabeth to relieve him of it. He was accordingly given a post in Lancashire, and he thanked the Queen in terms more forcible than polite for having delivered him from two devils.

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Phases of Modern Science.

By "Onlooker."

An article-review of the book issued by the Royal Society in connection with the Science Exhibition at Wembley.

THE first impression, on glancing through this book, is that there have been compressed, between the covers of a slim volume, pronouncements on topics of current scientific interest by most of the leaders in physical and biological science.

It is published in connection with the exhibition of the Royal Society at Wembley, and is therefore intended (as the exhibition is) for a general rather than a scientific public; for the reader, in fact, who looks on science as one among a number of interests with which books can keep him in touch, and is anxious to know something of the best that is being thought and done in the wide field of modern research. Such a person may or may not have some professional intimacy with scientific work or teaching, but we may suppose him to have at least some general knowledge of literature as a whole, and we may be certain that he will read this book and judge it by much the same standards as he would use for any other piece of writing.

Publicity for Science.

The literary public is hardly dealt with where science is concerned. In periodical literature, as often as not, and with a few notable exceptions, the choice lies between what is technically accurate and dull and what is sensational and quite untrustworthy. This generation has seen science take its place as an essential element in education, and scientific experiment, once carried on in fear and secrecy,

has now become a part of every boy's work at school. Indeed, with such innovations as electric bells and lighting, telephones and wireless, it is practised in every household. Yet there seem few enough of writers who, having the necessary knowledge of science and, more important, understanding and enthusiasm for the objects and purposes of research, combine with these qualities the purely literary faculty for selecting and arranging material and presenting it in a readable form.

Co-operation by Leaders.

Even in the case of more permanent writing, the publication of a book which deals authoritatively with some aspect of scientific work or thought, and at the same time bears criticism by literary standards, is a rare enough occurrence. No doubt it will be said that the scientific and the literary ideals are incompatible, and that he who sets out to strip from scientific truth her garments of austerity and to clothe her in something more becoming, had better save his pains. Doubtless there is much in science that must always be the secret of those who practice it. But equally without doubt, there is much more that need remain no secret, if those who are initiated would but consider the prejudices and limitations of their less fortunate readers. Science and the world of science, regarded as a field for the purposes of literary endeavour, is practically untouched.

Moreover, modern science has everything to gain by an effort to communicate the essence of her striving to a wider audience. The philosophy of nature, with its increasing technicality and the diversity of its aims, has long since lost touch with the simpler purposes from which it has sprung. Perhaps inevitably. But we must be on our guard against man's ineradicable tendency to " make mystery " of his doings. What is not understood will not be estimated at its true value. Science, for her continued progress on a fruitful course, needs, like any other activity, that sympathetic co-operation of other interests which can only come with a widely diffused knowledge of her aims.

It is, therefore, a cause for congratulation that the great men of science should co-operate in the production of a book, and the arrangement of an exhibition, for the benefit of the general public. The exhibition we are told, has been paid for out of public funds ; but its arrangement has been in the hands of the Royal Society, and the majority of the authors who have contributed to the book are distinguished Fellows of that body—surely a new phase in its activities. Let us hope that this may be regarded only as a first step. Nothing but good can come of an effort, so admirably initiated, and with which many of the greatest names in science in this country are associated, to spread a wider knowledge of modern science.

Much of what is included in the book is admirably suited to the purpose. In some twenty-four articles, many of them quite brief, practically the whole field of modern physical (but not chemical) activity, and a large part of biological work, are covered. Most of the articles are such that the general reader may read and grasp without difficulty, gaining thereby very clear ideas as to the position of present-day theory and achievement.

Nothing better of its kind can be imagined than the first and longest essay, that of Sir Oliver Lodge on " Radiation." It is divided into three parts, and deals first with the atom as the ultimate source of all radiation. The atoms of the chemical elements, conceived by Dalton, have given place, in the light of more recent research, to a simpler view of the constitution of matter, that based on the electron and proton, the natural and fundamental units of negative and positive electric charge. These, the particles or atoms of electricity, are the bricks with which nature builds. In their varied groupings and arrangements they enter into the constitution of matter in all its variations, and are sufficient to account for its properties. The physical universe consists of these two kinds of things, and also of one other, " the radiation due to sudden movements and rearrangements among those charged particles," the electrons and protons. " It is by this third or apparently supplementary, subsidiary, or accidental, consequence of the spasmodic behaviour of the other two that we know anything about them."

Radiation.

Sir Oliver Lodge explains that " the most usual view of radiation is that it consists of waves in a connecting medium, commonly called ' the ether ' " ; but says, impartially, that some do not care to use the term " ether," and are not sure of the nature of the waves, although no one doubts the fact of radiation.

The second part of his article describes the spectrum of radiation. The visible spectrum has been extended, and although the eye cannot observe them, there are radiations which can be detected by other means. Thus the ultra-violet rays, X-rays and gamma rays from radium are radiations having a shorter wave-length than that of violet light. Similarly, the infra-red rays are waves of greater length than those of red light. Moreover, following from the work of

Clerk-Maxwell, who first saw that light could be regarded as an electro-magnetic radiation, this extended spectrum may be linked on to the whole range of "ether" waves, generated by purely electrical means, such as are used in wireless. These also, it is now well known, travel with the velocity of light.

The extended spectrum of radiation is also dealt with in an interesting and very valuable chart, which appears as a frontispiece, showing the complete range of electro-magnetic waves as it is known at present. It must be mentioned that the whole range, from the shortest known gamma rays to the longest electrical waves, is shown in this chart, probably for the first time, without a gap, all intervening wave-lengths having been experimentally detected or generated. The final section of Lodge's essay is devoted to the longer or "wireless" waves, their generation and application to signalling, and the analogies between the long and short wave phenomena. Comparing the visible spectrum to the range of wave-lengths permitted for broadcasting purposes, he says, for example, that long-wave stations like Chelmsford may be regarded as being far down in the infra-red!

The Electron.

Other physical articles include one by Sir Joseph Thomson, admirably brief and to the point, telling exactly what an electron is. Sir Ernest Rutherford, in "Electricity and Matter," describes how, on the nuclear theory of atomic constitution, for which he is responsible, the electron and proton enter into the structure of matter; and shows how the researches on the disintegration of the radio-active elements have given information on the structure of atoms. Professor Fowler, one of the Yarrow Professors of the Royal Society, in "The Origin of Spectra," deals with the important field of research in which the spectra of the elements are related to their atomic structure, according to the theories of Rutherford and Bohr.

Those with any knowledge of wireless must be interested in "The Origins of Wireless" by Sir Richard Glazebrook, describing briefly the progress from the earliest electrical discoveries to their latest application in wireless telephony and broadcasting; and in the article on "Thermionic Valves" by the inventor of the valve, Dr. J. A. Fleming.

It is not necessary here to give a list of the articles, but mention must be made of the admirably chosen biological series. The essays by Sir Arthur Smith Woodward on "The Origin of Man" and by Dr. E. J. Allen on "Life in the Sea," speak for themselves as to subject, and it would be impossible to have anything more admirably suited to the purpose of giving to a general reader some idea of modern knowledge in these branches.

These and other biological articles, such as "The Human Brain," by Professor G. Elliot Smith, and "The Circulation of the Blood," by Professor E. H. Starling, are fascinating to read and very valuable for the brevity and enactness with which the knowledge of their authors is imparted.

Criticism.

It is, perhaps, ungracious to criticise a book in which so much is excellent but, bearing in mind the particular purpose it is intended to serve, it must be said that, here and there, one or two of the authors are unnecessarily technical. The impression is strong in a few (but only a few) of the articles, that the ideas could have been conveyed in simpler language; or at least, where technical terms are unavoidable, that they could have been made more explicit in the context. One of the principal influences which has cut science off from general literature is the growth of the scientific vocabulary, and while this cannot be wholly avoided, it must always be remembered that the non-scientific reader requires education in this respect, and greatly appreciates any concession to his limitations by which the necessity for constant reference to a scientific dictionary is avoided.

The second part of the book is the handbook to the exhibition, but this is much more than a mere list of the exhibits. The arrangement of a large part of the physical exhibits, on the basis of the extended spectrum of radiation referred to previously, is indicated by marginal headings, so that the reader may see at a glance to which part of the spectrum the experiments described are related. Moreover, many of the descriptions are themselves short and lucid essays, for example, that of Mr. D. R. Hartree on the "Models Illustrating Atomic Structure," in which present ideas of the nature and structure of atoms, on the basis of the work of Thomson, Rutherford and Bohr, are summarized.

To the teacher of science who wishes to keep abreast of recent research, this volume of two hundred and thirty pages should be invaluable. It deals with work which, for the most part, has not yet found its way into the textbooks, and for which it would be necessary to consult the original papers. It is probable that to many such readers a publication of this kind from time to time, if not annually, would be of great interest.

"Phases of Modern Science." Published in connection with the Science Exhibition, arranged by a committee of the Royal Society, in the Pavilion of H.M. Government at the British Empire Exhibition. (A. & F. Denny Ltd., 163a Strand, London, W.C.2. Three shillings and sixpence. Postage sixpence).

Researches on the Plumage Factor in Birds.

By Professor C. J. Patten, M.A., M.D., Sc.D.

Professor of Anatomy, Sheffield University. Author of "The Aquatic Birds of Great Britain and Ireland," "The Passing of the Phantoms," etc., etc.

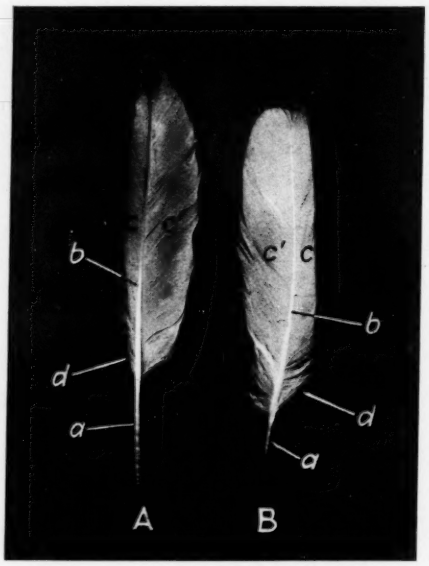
Fine feathers make efficient birds as well as fine ones. There are, nevertheless, many very puzzling matters connected with plumage which require explanation and which are now attracting the attention of ornithologists.

SURELY, beauty is the hall-mark of the bird creation! Beauty not only in plume, but also in form, deportment, flight, song, and other features. This crowning gift of Nature finds its fullest expression in the highest classes of birds, many of which are familiar garden companions. The slouching vulture and the starchy-stiff scabrous-headed adjutant stork may cut a sorry figure when aground, but afloat o'er head their wheeling, circling, or gliding flight is the very poetry of motion, "a thing of beauty and a joy for ever."

Colour.

It is true that beauty may not be present in its fullest perfection in all classes of birds, but it is never altogether absent, and where it lacks in the one it stands out prominently in the other direction. The plumage of the vulture if plain in pattern takes first rank in the beauty of its architecture correlated with wonderful powers of flight. Again, where song has reached its high-water mark of melodious and artistic beauty, Nature has toned down the gaiety of the vocalist's dress. Our most famous feathered artists come on to the "platform" clad in modest attire. This, however, does not put out of court a small group of excellent songsters which are arrayed in gay and in some cases strikingly beautiful dresses. Our lovely little goldfinch with his wings of spangled yellow and black and his face of tinselled gold, also our prettily marked chaffinch, redstart, and robin, are familiar examples.

In North America we have the cardinal, otherwise known as the "Virginian nightingale," whose joyful carol thrills the woodlands, whose vocal energies remain unimpaired in the darkest hours of night, and in whom the beauty of song keeps pace with his beautifully rich crimson cloak. Among some birds the splendour of their plumage is dazzling; only with blossom can plume vie in beauty. And can we compare the two and with justice assess their superiority of shade and tone? It seems hardly possible where structure, and especially texture, are so very different. We do know, however, that an individual flower is restricted in its range of colouration, while



(Photographed from Nature by C. J. Patten.

FIG. 1.—ANATOMY OF A FEATHER.

(A) Wing-feather; (B) Tail-feather; of a Black-headed Gull (Dorsal view). (*a*) Barrel or Tube; (*b*) Shaft; (*c*) Narrow outer web; (*c'*) Broad inner web. The two webs together form the Vane. The Vane is composed of numerous obliquely directed filamentous laurellae called Barbs. (*d*) Basal Barbs loosely arranged giving a "fluffy" appearance. The Barbules and Hooklets, which connect the Barbs together, are too minute to be seen in the illustration.

Use and Beauty.

a bird, on the other hand, may exhibit in its plumage almost every possible combination. The plumage factor in birds is *par excellence* an example of "Use and Beauty." This becomes manifest by making a brief survey, firstly, of the structure and functions of the feathers; and secondly, of the colouration and pattern of the plumage. The feathers of a bird form quite a comprehensive study, and here we can only touch upon the fringe of the subject. Feathers themselves vary enormously; compare for instance the "*down*" of the nestling; the exquisitely delicate filamentous plume of the egret ("osprey"); the wavy neck "hackle" of the domestic fowl; the minute scaly wing-feather of the penguin; the naked shafted wing-feather of the cassowary; and many others too numerous to mention. The structure of such very modified and specialized plumes need not here concern us, nor need we examine the plumaceous wavy feathers of non-flying birds, such as the ostrich or emeu.

It is in regard to the typical feathers of a flying

(*Photograph by C. J. Patten.*

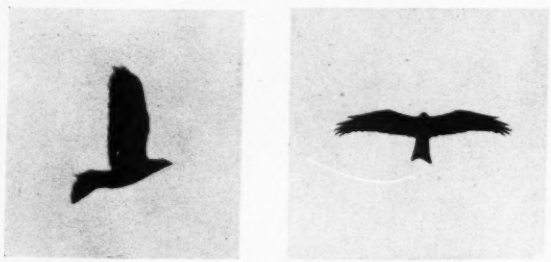
FIG. 2.—DORSAL VIEW OF A DEAD TURTLE-DOVE.

The wings are spread to show the manner in which the long flight-feathers are disposed. It will be seen that the feather nearer to the body always overlaps the broader *inner web* of its adjacent neighbour. To put it more concisely, the proximal feather overlaps the inner web of its distal neighbour.

bird that I propose giving a very general account of their structure, function, and distribution. An ordinary perfect and fully-grown feather is composed of the following parts: a thin transparent tube, the base of which is implanted in the skin. The other end of the tube passes directly into the shaft*

Anatomical Detail.

which is solid, tapering, and curved, and flanked on either side by the webbing, called the "vane," which in turn consists of very numerous filaments, the "barbs." These are kept together by smaller filaments, the "barbules," which bear minute hook-like processes. The mechanism by which the barbs and barbules are held together is very intimate, so that



(*a*) (*b*)

(*Photographed from life by C. J. Patten.*

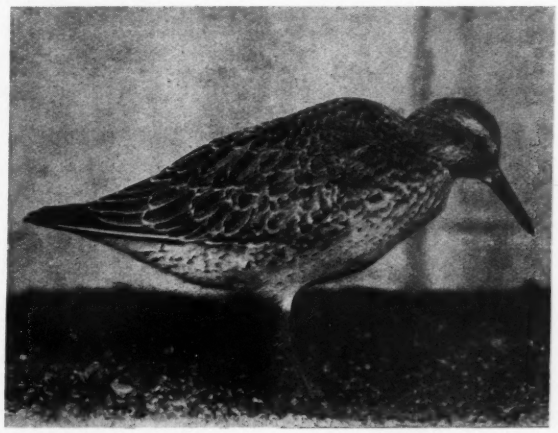
FIG. 3.

(*a*) Though rising. The tail is fanned, depressed, and carried forward in order to encompass the air and maintain full buoyancy when gaining initial velocity in flight. (*b*) Kite soaring. A full front view of the under surface of the bird is presented to the observer. The tail is rotated on its long axis through an angle of about 45°. Its forked extremity therefore appears asymetrical.

an appreciable resistance is offered when we try to separate the webbing. A feather is curved, its convex surface looking upwards and its concave surface looking downwards; it is also highly elastic. Each feather overlaps, and is in turn overlapped by an adjacent one. Collectively the whole plumage is made up of a system of overlapping feathers arranged like tiles or slates on the roof of a house. It is interesting to note that the feathers do not clothe all parts of the skin; on the other hand they sprout from well-defined tracts, nevertheless, the bare areas are easily covered by the ample size and spread of the feathers. Traversing the skin are extensive sheets of muscles which by their division into numbers of slips can act upon groups of feathers, or upon some individually.

Muscle Mechanism.

Just watch one of our little garden birds preening its feathers! In the first place observe the manner in which the plumage as a whole can be erected so that the bird makes itself appear like a soft fluffy ball.



(*Photographed from life by C. J. Patten.*

FIG. 4.—THE KNOT IN AUTUMN DRESS.

A typical and an abundant wading-bird, which (in company with many other common species), resorts to the sand-flats in autumn and winter wearing a finely mottled light grey dress, which is harmoniously adapted to the surroundings and therefore markedly protective. The nuptial dress, with its rich russet and blackish markings, also adapts itself to the breeding grounds.

Then we see how the short feathers of the upper and under parts are carefully combed by the beak, the process being assisted every now and again by the addition of a little oil extracted from the gland situated over the root of the tail. The tail itself is next erected and fanned, and its individual feathers treated in like manner. Lastly the long stiff flight-feathers receive attention and, as the bird spreads its wings and combs the pinions from base to tip, one may sometimes detect that they have been rotated on their long axes so that a gap appears between each adjoining plume. Startle the bird! In a flash it lowers and tightens its body-feathers (which now overlap in the closest manner possible), closes up its tail and wings,

(*Photographed from life by C. J. Patten.*

FIG. 5.—GROUP OF PUFFINS.

The puffin is rendered conspicuous by its black and white plumage, bright orange feet, and prominent beak gaily "painted" in blue, yellow, and carmine. The young bird is almost similar in plumage. Moreover the nestling is noticeable by being entirely black. Discarding protective colouration this very sturdy species—a swift and powerful flier and diver—has held its own and multiplied prodigiously in remote maritime situations where, relatively speaking, its enemies are few in number

and stretching its neck and limbs, makes itself look as compact and sleek as though it were robed in a tightly-fitting silken garb. The aptitude which a bird possesses of treating the individual feathers with meticulous care, at frequent intervals, is a matter of importance. For, preparatory to taking flight and also, in the case of the male, in "displaying" before the female, the plumage must be in perfect

Feather Controls.

order; each feather as it overlaps must fall naturally into its own place to allow the skin muscles to act upon them when necessity arises. In warm weather the body-feathers are frequently raised to allow a current of cool air to play on the heated surface of the bare areas of skin, for a bird has no sweat glands through which heat can be lost by evaporation. When, on the other hand, the bird wishes to present itself as a compact and an impervious mass to the air, notably during rapid flight, all its feathers, with their curved surfaces and elastic properties, are closed down until they tightly overlap, and in this way become perfectly adapted for the purpose.

Let us now consider for a moment the main features of the long wing-feathers in their relation to flight. The outer webs are much narrower, more resisting, and thicker than those of the opposite side. It therefore follows that during the downstroke of the wing the resisting air acts more strongly upon the inner webs, and presses them up in such a manner that each feather is brought into close contact by its broad inner margin to that of its fellow which overlaps it on the side nearer to the body. Again, the concavity of the under surfaces of these flight-feathers is reduced by the upward pressure of the air during the downstroke of the wing. When the greater *pectoral* muscles, which lower the wings, cease to act, the flight-feathers,

Flight Mechanism.

by virtue of their own elasticity, immediately regain their original curvature; by this mechanism the strain put upon the outspread wing as a whole is lessened. The flight-feathers also readily rotate upon their long axis so as to release the compressed air which, at the end of the downstroke and during the initial stages of the upstroke, can then escape from under the wing through a series of gaps, comparable to the manner in which the light can pour through the gaps of a Venetian blind when its laths are raised and separated. The webs of the tail-feathers are built on the same plan as those of the wing-feathers. They overlap in the same fashion and by their intimate relationship can encompass the resisting air and render it impervious. The movements of the

(*Photographed from life by C. J. Patten.*

FIG. 6.—THE MISSEL THRUSH.

The Missel Thrush, and other typical members of the family to which it belongs, show conspicuous mottling of the plumage of their under parts. The young are almost similar except that the spots are found sparsely intermingled on the upper parts. It is a generalized plumage which has been retained by the female and young blackbirds, notwithstanding that the adult male blackbird has become uniform black in colour. The blackbird is a member of the thrush family.

tail-feathers are very free: they can be separated so as to form a broad fan; they can be rotated, depressed, and elevated. When the feathers are sufficiently long and suitable in shape, the tail as a whole may act as a "*fine adjustment screw*" in steering. This mechanism is brought into play, and is quite noticeable in the superb gliding, wheeling, and soaring movements of kites and some other hawks, and particularly so in the hovering kestrel. I have repeatedly noticed it in rooks and pigeons during their aërial gymnastics. The finely adjusted movements in "tail steering" consist of partial or complete rotation of the fanned-feathers to the right or left, the action being that of an aërial rudder. The fan can also be depressed and carried well forward in order to encompass a column of air when the velocity of flight is suddenly checked, and, consequently, a full measure of buoyancy of the bird's body demanded. However, in ordinary flapping-flight the use of the beautiful aërial rudder is, for the most part, set aside, and steering is effected by "*banking*," or "canting," which means that the bird tilts its body over to one or other side, a movement which is accompanied by alteration in the expanse, angle, and rate of flap in one or both wings. It is evident that in heavy birds provided only with small, short wings, and a tail of insignificant or negligible dimensions (duck, waterhen, grebe), steering must depend *in toto* on *body-tilt* and *wing-adjustment*. In such birds, leisured flight—in which the tail movements play such a prominent part—could not be expected.

Weather Effects.

The flight-feathers are covered above and lined below to a considerable extent by numerous smaller feathers. The upper series are curved and intimately overlap in a similar manner to those which clothe the body. The lower or lining feathers are less curved—some being quite straight—and overlap with less regularity. The upper series can be raised and separated from the flight-feathers to facilitate the escape of air when it is being liberated from beneath the wings. Feathers as a protective covering are not particularly efficient. Plumage—except in the case of aquatic birds—readily becomes water-logged, a circumstance which explains why it is that land birds immediately take shelter in wet weather. Feathers, when fully soaked with water, not only become dragged and dishevelled, but also so heavily weighted (much more proportionately than wet fur), that the flying powers of the bird might temporarily become seriously, if not altogether, incapacitated.

Having now very briefly sketched out the plumage, indicative of its utility and irrespective of structural and functional characteristics of the beauty, we can sum up by saying that in the case of the typical flying bird, clothed in the more ordinary typical plumage, *the primary use of all the feathers, great and small, is intimately associated with flight*. The plumage of birds is a highly specialized clothing which has evolved to meet the needs of a highly specialized creature who, during the major part of its existence, is in truth a denizen of the air.

The Use of Beauty.

The colouration, pattern, and "*display*" of plumage may now be briefly considered. Here, in treating of habits of life rather than animal mechanics, we shall have opportunities of observing fascinating examples of *Use and Beauty*, and the manner in which they go hand in hand. Nature carries forward her children by sparing the more vigorous and those who react best to their environment and who harmonize most closely with their surroundings. The harmonious blend is often curiously true and beautiful. The woodcock in his dress of rich russet-brown vermiculated with black, is indistinguishable as he crouches amidst the dead bracken fronds, dried leaves, broken bits of sticks, and such other undergrowth which forms the ground-work of the umber shades in autumn's woodland glade. His whereabouts can only be detected when his prominent black eye comes into view. Though migratory and widely distributed northward from Scandinavia, up to the limit of tree-growth, southward down to the Mediterranean basin, this interesting bird retains its harmonious woodland plumage unchanged throughout the year. The snow-bunting, a charming little bird which visits the British Isles in large numbers every winter, being an inhabitant of the open country, changes its plumage to suit its environment. In its breeding-haunts, in the Artic wilds, most of its plumage is pure white, but in winter when it descends to temperate climes many tawny markings appear which besmirch the purity of the nuptial dress. Our red grouse has a remarkably circumscribed distribution, for it is not found outside the British Isles. In winter, as one would expect, it retains its reddish-brown mottled garb, but its representative (a distinct but closely allied species), the willow-grouse which inhabits Northern Europe, Asia, and America, assumes a snowy-white dress in winter. In many cases immature birds exhibit a different plumage from their parents. When the adult male differs in plumage from that of the female by being more beautiful and conspicuous, the young of both sexes resemble their mother. Instances of

such occur among great numbers of birds of diversified classes, viz.: ducks, fowls, hawks, and finches. The house-sparrow is one of the best and most familiar examples.

Mottled Ancestry.

Furthermore, when the males of different species, but belonging to the same family, differ markedly in plumage, not only from their respective females but also from each other, all the females and young bear a general resemblance to each other in the type and pattern of their plumage. This is well illustrated in three familiar members of the grouse family, viz.: the capercaillie, the blackcock, and the red grouse, in which the plumage of the females and young are greyish and mottled. Among birds of the mottled type, such as the thrushes, in the majority of cases the adults and young of each species are almost alike; in the exceptional case of the blackbird—a member of the thrush family—where the male differs in dress from the female, the latter and her young, in their brown and mottled colouration and pattern, follow the thrush type of plumage. Then there are birds in which, when the parents are alike, their young differ from them in plumage. Here we are not confined to classes or families, for we find this condition in most diversified forms. We have only to think of the mottled breast of the young robin or the completely mottled plumage of the young herring-gull or black-backed gulls, out of hundreds of other instances. Now how are we going to interpret these interesting facts? The reason is not far to seek, for obviously the mottled character of plumage predominates in the females and even more so in the young, and seeing that it occurs in many and highly diversified classes, it indicates that, through the long vistas of evolution, many forms of birds have arisen and diverged from an ancestral stock which bore the mottled type of plumage. One would expect birds with this type of plumage to prevail and become widely distributed, seeing that a plumage-pattern (or for that matter a coat of fur), made up of streaks and spots on a ground-colour of varying shade, would closely harmonize with vast areas of Nature's surroundings. For we must bear in mind that the mottled garb has varied from the finest to the coarsest pattern, and from light to dark shades. There is no doubt that in the past the more generalized and primitive mottled plumage served a protective purpose anent the struggle for existence, and there is ample evidence to show that this factor is still being maintained. Nor have we any reason to doubt that in many cases, where males are conspicuous and gaily attired, the subjugation of beauty in the dress of the female and young may serve the useful purpose of protection. But millions of years have rolled on since the foundation of the avian dynasty, and now we find many species which have adapted themselves so adequately to their surroundings, and in their mode of life have proved so superior to their competitors that they have been able to discard the mottled garb altogether. Nay more; at the present day there are many birds of whom not only the male and the female possess beautiful and very conspicuous plumes, but also the young are likewise endowed. Look at our kingfisher as he darts along the stream, flashing like a jewel—an emerald or a sapphire according as the light strikes him! Do his surroundings suggest protection? No. Here Nature seems to present a discord between plumage, dazzling in the splendour and brilliancy of its colouration, and the sombre, sometimes murky, vegetation of a British stream, a reservoir, a ditch, or a mill-pond. We might almost fancy that our kingfisher had strayed from a tropical riverside where his plumage would have blended with its brilliant surroundings. How then has the kingfisher managed to survive in our country and, moreover, hold his own so competently? Because in the first place his swift darting flight just clear of the surface of the water saves him from the clutches of the hawk; then his shyness, coupled with his extremely sharp sight, enables him to take flight a long distance off and thus slip away unobserved around the bend of the stream; while his solitariness, his silence, and his motionless figure perched upon a twig awaiting to plunge upon his fish, render him less conspicuous to the casual visitor than his brilliant

Blackbird Puzzle.

dress might lead one to think. We seldom detect the presence of a kingfisher until in flight he flashes, like a precious jewel. The female is nearly as brilliant in plumage as her mate, but as the nest is placed out of sight in a hole in a bank, she needs no toning down of her colours to protect her when incubating. Many other species in which the two sexes are gaily-plumed also breed in holes; on the other hand there are those which build nests in the open. Therefore, while the advantage of protective colouration of the plumage, when birds are nesting, has been made somewhat axiomatic, it is not by any means universal. On the contrary, there are many classes of birds whose plumage and *natural habitat* are out of tune, in fact, offer a sharp discord, who have survived and flourished in the struggle for existence. A totally black bird is conspicuous almost everywhere, and *a priori* we should imagine that such a bird would be shy and endeavour

to elude observation by keeping to secluded localities. But look at the crow, the rook, the jackdaw, and the magpie, the contrast colours in the last-named being even more conspicuous. These birds come right out on the open to feed. True, they are vigilant and wary—persecution has made them so—nevertheless, they are bold, daring, mischievous, thieves, and so astute and alert that the moment one's back is turned they are usually successful in their piratical escapades. It is quite evident then that the habits of the crows (sinful as they may appear to our ethical ideas !) bespeak considerable intelligence. In captivity their intellectual endowments can be brought out to a wonderful degree ; moreover, crows have a versatile brain, for they will exchange their crafty suspicious traits for confidence and love. Now from the beginning the young of the crow-tribe are almost as black as their parents, and hence are always very conspicuous ; they hold their own therefore by virtue of their intellectual qualities, coupled with bodily size, strength, and fitness, rather than by protective colouration.

Decoration and Display.

A few words in conclusion regarding the *" display " of plumage* by the males. Here, in particular, one sees that birds no doubt have a taste for the beautiful, and a highly developed sense of colour. The plumage of many birds, apart from the beauty of its colouration and pattern, is highly decorative. The decorations are varied to a wonderful degree, and are not confined to any particular region of the body. Thus head-crests, filamentous neck-plumes, tufts and tippets, modifications in the shape of the wing and tail-feathers (which are often excessively developed), are familiar examples. These ornaments are carefully displayed before the female in the breeding-season who, in making her choice of a partner, is influenced by the beauty and perfection of the plumes. The manner in which the males *" display "* varies according to the distribution and pattern of the decoration. The ornamentation is always presented directly at the female. We are all familiar with the impressive spectacle of the proud peacock when, facing the female, he erects and fans his immensely elongated and gorgeous tail-coverts which, when fully spread transversely to the body, not only reveal the unique beauty of the *" ocelli "* but also form a background which blends harmoniously with his throat and breast of superbly rich-toned azure blue. Many kinds of birds are endowed with neck-frills which they erect and expand, at the same time altering frequently the position of their flexible necks to enable the female to maintain an uninterrupted view of the ornamentation. Display of plumage during courtship appears to be universal. For instance, birds which are not equipped with specialized decorative plumes will show off the brightest part of the ordinary plumage. The robin, the bullfinch, and the chaffinch, present their rosy breasts, at the same time erecting the feathers to make them look as large and fluffy as possible. The last-named also expands his wings to show the conspicuous milk-white bars. The goldfinch, when he opens his wings, renders the brilliant sulphur-yellow bars very noticeable, and as he sways his body from side to side in a most enticing manner, the wing-bars produce a golden flashing effect. The blackcap erects his little head-dress, the only conspicuous plumes he owns ; the wheatear spreads and erects the white feathers of his rump ; the redstart fans and jerks his tail of glowing fire. In conclusion let me venture to say that the study of plumage display is one of the most fascinating in the whole domain of ornithology, and begs of most careful interpretation. It is an extremely comprehensive study, and here we have been only able to take a passing peep at it. Nevertheless, I believe that we have been able to grasp one supremely important point, namely, that decorative plumes may, on the one hand, have evolved to such cumbersome dimensions, or may, on the other hand, have become so bereft of their normal and functional architecture, that the powers of flight may have been seriously or *in toto* impeded ; a state of affairs which would certainly appear to militate against the chances of survival in the struggle for existence. But since decorative plumes and other " fancy dress " elaborations have proved highly advantageous in courtship, it may here be said that Love is stronger than Death.

* Here, where the webbing begins, a small replica of the feather called the "aftershaft" springs. It is a secondary feature, very variable, and often absent.

EGGS AND SCURVY.

SOME recent work upon eggs casts grave doubts upon the truth of the old saying " as full of meat as an egg." At all events, experiment shows that its value as a source of Vitamin C is negligible. Guinea pigs fed on the eggs laid by hens taking a diet especially rich in Vitamin C speedily contracted scurvy. Furthermore, guinea pigs that should have been immune, showed themselves particularly prone to the disease when fed upon such eggs. If these experiments are substantiated all our ideas concerning the beneficial properties of eggs will have to go by the board. It will further confute certain schools of American thought who have long extolled the anti-scorbutic value of the egg.

The Problem of Miocene Man.

By J. Reid Moir.

Pleistocene man is accepted, but it is by no means certain that we ought not to shift the distant horizon of humanly worked flints even further back into the Miocene period. The evidence at present collected is being submitted to critical scrutiny and important pronouncements are expected.

THE antiquity of the human race is being gradually extended back into the remote geological past. The fact of the existence of flint implements, and human fossil bones, in the deposits of the period preceding that in which we live, is now scientifically established, and Pleistocene man is accepted by all those who have troubled to examine the evidence bearing on this question. Recent researches, carried out in East Anglia, have shown that humanly-flaked flints occur also in the still older Pliocene beds of that region, and the presence, upon this planet, of makers of rudimentary flint implements at this ancient epoch, is widely recognized.

A Million Years Ago.

Passing backward in time from the Pliocene we enter the Miocene epoch, separated from the present by, perhaps, a million years or more and, owing to certain discoveries made in Upper Miocene deposits, at Aurillac, in France, the question is now being raised as to whether these discoveries are to be regarded as indicating the existence of intelligent beings at this profoundly ancient phase of the earth's history. Naturally, because of its importance and complexity, this is a problem that needs very careful and expert examination, and no final decision can be arrived at until such an examination has been made. But, as some of the Aurillac specimens have been already described by various observers, it may be of interest to give a brief account of these Miocene relics, and the place where they have been found. Before doing so, however, it is perhaps as well to point out some of the implications involved in the acceptance, as of human origin, of the Pliocene flints of East Anglia. These specimens are found beneath the marine shelly sands, known as "Crag," and occur in a deposit—the remains of an ancient land surface—at the base of these beds, which is made up of materials of varying ages prior to that in which the implement-bearing bed was accumulated. There are in this deposit, for instance, a certain number of mammalian remains known to be of Miocene age, and with these the flaked flints sometimes lie in intimate association. Therefore, though the bed itself in which the implements occur is of Pliocene age, these specimens may well be much older than this period and, in fact, referable to that of the Miocene.

Aurillac is situated in the department of Cantal, Auvergne, a wild and beautiful part of France, and there can remain no doubt as to the geological age of the deposit from which the specimens under discussion have been derived as, apart from other considerations, this bed contains the remains of Upper Miocene mammals, such as *Mastodon longirostris* (an ancestral form of the modern elephant), *Rhinoceros Schleiermacheri* and *Hipparion gracile*, the three-toed precursor of the horse.

The point at issue, therefore, is whether the flaking of the pieces of cherty flint found with these fossil bones has been accomplished by man—or by the unguided forces of nature. An examination of a large series of the Aurillac specimens, such as was collected by the late Mr. Ernest Westlake, of Fordingbridge, shows clearly that the implemental forms were derived from the flaking of the large blocks of tabular flint, associated with these forms, in the Miocene deposit.

Human or Natural?

Flakes have been detached from these blocks, and then trimmed into the shapes of various scrapers, borers, and points—such as we know were in use in nearly every phase of the Stone Age. The Aurillac technique is of the simplest character, representing as it does merely the detachment of flakes, and their subsequent modification by secondary flaking, and it would seem, might well have been carried out by beings of rudimentary intelligence living in the Miocene period. It is of importance, too, to note that at Aurillac there are present certain large flints, of a more or less pyramidal form, showing localized battering at the narrower end, and it is possible that these may have been used as hammerstones in the manufacture of the flaked specimens. Is it possible, however, to regard these as having been produced by natural agencies?

There are three ways in which nature can fracture flint, viz.: (*a*) by the effects of extreme heat and cold; (*b*) by percussion, as for example, in a fast running stream, or on a sea beach, and (*c*) by the pressure of a great mass of overlying strata. The

first mentioned method is by far the commonest adopted by nature, while the second, though frequent, results in the detachment of smallish flakes of a peculiar and obviously natural kind. The fracturing of flint by pressure is the rarest of nature's methods, but the results of this force—in some cases, simulates, intentional, human flaking very closely, and it remains to be decided whether the implemental forms found in the Miocene deposit at Aurillac have been shaped by natural pressure or by the hands of some rudimentary, flint-flaking, individual. An examination, made by the writer some little time ago, of Mr. Westlake's collection, left the impression that the latter was the true explanation, but the question is of much archæological importance, and must be gone into with the greatest care before a final decision is reached. The Westlake collection is at present being studied by Professor W. J. Solles, of Oxford, who has publicly stated his intention of reading a paper upon the whole question in the near future—and the results of his deliberations will be awaited with the keenest interest by all those who study the past history of man.

The Miocene period was one in which a very warm temperature obtained in Western Europe, and a large number of mammals, including anthropoid apes, had then made their appearance in this area. The presence, therefore, also of semi-human beings who made primitive flint implements is by no means an impossibility.

Zoo Photography.

By A. H. Hall, C.B.E., M.I.C.E.

Cameras are much in evidence at the Zoo, but results are often disappointing. The author is the leading expert on animal photography, and the article embodies the results of much experience.

It was, I believe, the late W. H. Hudson who expressed the greatest aversion to seeing any wild animals cooped up in cages, holding that they were so miserable that it was better to keep none in captivity.

I cannot subscribe to this view ; with the exception of a few animals, who never get used to the conditions, and possibly some of the larger birds of prey, most creatures appear to find captivity at least tolerable, and to most people it is the only opportunity they ever get of seeing wild animals. It is recognized, too, that the larger carnivoræ, when suitably housed, are often in better condition than when wild.

Type of Apparatus and Size.

The photography of animals under restraint is an easier matter than under natural conditions and, though most of those who attempt zoo portraits will never have the opportunity of work in the wilds, many of the problems are the same, so that anyone who has mastered the not inconsiderable difficulties of zoo photography will have served an apprenticeship which has called for most of the qualities demanded of the nature photographer. He will have exercised exemplary patience, quickness of decision and judgment, and will learn that without some knowledge and understanding of his subjects, caricatures are easier to obtain than portraits.

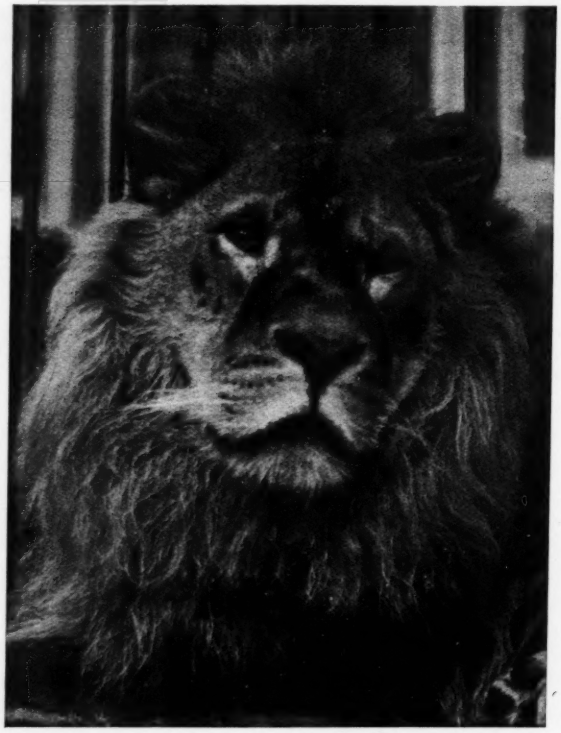
Good results can be obtained with any camera if used with care, but the specialist will find that ninety per cent. at least are best taken with a reflex camera ; for the remainder a reflex is possible, but a folding camera with a direct vision finder will be more handy.

Any standard reflex is capable of good work, though preference should be given to one in which the shutter is reasonably quiet at the low speeds, and it is important that it should have plenty of extension, so that large heads at close range are possible. In the less costly patterns the mirror is raised by the lever which releases the shutter and, where the camera is held against the wires of the cage this is no disadvantage, but the type in which the mirror is raised independently of the shutter-release is easier to hold still without support at slow speeds. This mechanism is expensive, but is fitted to most of the highest grade cameras, and in addition allows the camera to be used at eye level by holding it upside down, a difficult but sometimes useful method of manipulation.

Most of the experts use either quarter plate, the largest size allowed without a special permit, or five inches by four, but I find that $3\frac{1}{2}$ in. by $2\frac{1}{2}$ in. is an ideal size. With large aperture lenses used at close range the depth of focus is quite restricted enough, and on larger plates, for this reason, the image is often kept down in size, so that there is a large and unwanted margin on the plate. This size is also ideal for lantern slides by contact.

If only one lens is used, I should recommend one of about 5 in. focus working at f(3·5), though a telephoto lens of 9 in. focus is necessary—for some of the small birds particularly—and a 7 in. lens working at f(4·5) is also most useful. For larger sized plates, of course, the focal lengths should be proportionately longer. As the subjects may be taken under unfavourable lighting conditions I always use plates or cut films of the highest speed.

It is necessary to carry a good supply and a reliable changing box, or Mackensie Wishart slide with plenty of envelopes, are both convenient. Some expert workers rely largely on film packs, but I am one of those unfortunate individuals who, for no obvious reasons, get a larger percentage of failures on these films than on other sensitive material.



LION TAKEN THROUGH THE BARS OF THE CAGE.

Special Considerations.

There are several points which are not usually encountered in other branches of photography. The wires of the cages will not show if the lens is held close to them, though they may cut off a considerable amount of the available light. Care must be taken that the sun is not shining obliquely on the wires in front of the lens, or streaks will appear on the negatives. Of course, the shadow of the wires or bars on the subject must be avoided by choosing a time when this does not occur.

When working at very close distances, extreme accuracy of focussing is necessary, and even if the register of the dark slides is perfect, a percentage may be found with the plane of maximum sharpness too near or too far back. This effect varies with the individual, who should watch most carefully that the focussing screw is not being moved slightly while the shutter is being released. If there is any difficulty in seeing the image clearly, when very accurate focussing is necessary, a pair of magnifiers, adjusted to the user's sight, should be fitted into the hood.

It is necessary also to remember that the Zoo is supported by the general public more than by photographers, and it does no good to remonstrate when a spectator deliberately feeds your subject and spoils a position which you may have waited a long time to obtain. The less educated portions of the crowds, especially the visitors from the North and South Wales at holiday times, show more consideration than those from whom one might expect less active obstruction. The keepers of course, are always ready to give assistance, and their help is essential at times. It is recognised that they should receive a small sum for their trouble.

Early Work.

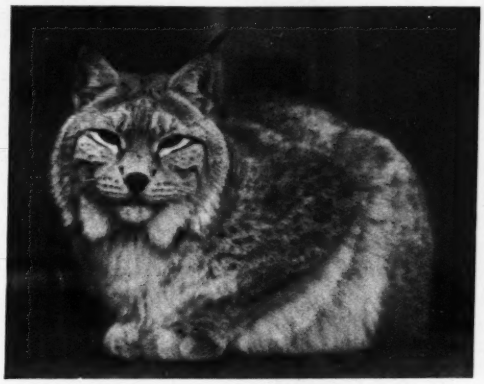
I should recommend a start on this work on definite lines. The beginner should try some of the easier subjects: llamas, some of the deer, the giant tortoises, or the eagles, with a shutter speed of about one twenty-fifth of a second, and the lens at full aperture with a fairly small image, and should confine his attention to focussing accurately and releasing the shutter promptly. When experience has been gained he will want to improve on these results by selecting his point of view, and perhaps changing his lens or stop, so that the background is unobtrusive; he will also carefully watch for the most effective lighting, and try and obtain a characteristic attitude.

To get the texture of the fur or feathers ample exposure is necessary, which means that the slower shutter speeds will often be required. Observation will show that the most fidgety of birds has some sort of sequence in its movements, with some point in that sequence of comparative rest, and the secret of using a slow speed is the selection of the right moment to make the exposure.

Special Subjects.

Space will not permit many details of the different types of subjects, but the lions and other large cats deserve a special word. The photographer must not climb the barriers and put his lens between the bars of the cages without the permission and assistance of the keeper, and should not ask this when there is a crowd. My work is generally confined to Saturday afternoons, and I have not attempted these fascinating beasts in London, though I have made many exposures on them at Clifton. There is little risk in so doing if the photographer is constantly on the alert, and never gives these animals a chance of using their claws. They will not normally do so, but the leopards and tigers especially are very quick, and a scratch from either may well prove a serious matter.

Modern wide aperture lenses have also made photography in some of the houses possible. Some of the reptiles, fish in the aquarium, the tropical birds, and those in the diving birds' house, and a few others can be successfully taken when the light is good, using the lens at full aperture and a slow shutter speed.



LYNX IN OUTSIDE DEN SHADED BY GLASS.
A fairly easy subject, but a rapid lens and a fast plate are essential.

The Unexpected Usually Happens.

One of the fascinations of this work is that one rarely takes what was intended at the outset of a visit. Not infrequently it is found that some difficult animal is in a good mood, and on such occasions it is wise to use most of the plates on a series at one cage, as the special object of the visit may not be in view at all. It is rare to spend two or three hours without finding something of exceptional interest to take.

Development.

It will generally be found that a goodly number of plates are exposed, and it is convenient to deal with these a dozen at a time in a tank. The time for development should be intermediate between that for studio portraiture and landscape work, which gives a fairly thin but well graded negative.

Special Faults.

The photographer will need to be very critical of his results, as the public, the press generally and, to some extent, the works on natural history do not exhibit this faculty, judging by many of the published

GIANT EGRET.
A snapshot taken inside the diving birds' house, f3.5 lens, 1/12 sec. exposure.

CONDOR IN THE OUTDOOR CAGES.

photographs. The Zoo catalogue is usually well illustrated with some good examples. One of the chief defects to be seen is distortion, either from taking the subject too close, or from pointing the camera upwards.

Some of the birds sit on perches at eye level and, unless a long focus lens can be used, pointing upwards is not kind to the sitter. It is always better to borrow a chair on which to stand if possible, otherwise these are subjects where a folding camera with a direct vision finder is an advantage. Focussing on the ground glass should be carried out carefully. Nearly all animals and birds have prominent features and the result of taking them too close will exaggerate their peculiarities. Apart from questions of focussing it is essential, for example, that an eagle's head should be taken in strict profile.

Results.

With the exercise of all care a considerable number of negatives will be spoilt by movement and other defects, and a visit which produces rather over fifty per cent. of good results on subjects of average difficulty would be satisfactory. When taking a series of a difficult creature a lower percentage must be expected. Without reckoning on the constant flow of new animals, there are plenty of novel photographs to be obtained, and some of these may have scientific interest. I believe it was only this year that the exact mode of display by the Argus pheasant to his mate was made clear by photographs. Incidentally, there is plenty of scope for a complete set of photographs of game birds displaying, while little has yet been done with high speed work on animals feeding. When printing the negatives, some extra copies should be made for distribution to the children as Christmas cards. Apart from their educative value a set of selected animals or birds is highly appreciated, and a comparison of one's annual efforts in this direction is a useful indication of progress.

BLOOD SUGAR OF CHILDREN.

For every stage of life there is a certain concentration of sugar in the blood that is normal for the particular age of the person. Recent American work shows that for children of about two weeks old and under this is less than for older children. For the first it varies from 0·072 to 0·096 per cent., and for children of six weeks to one year it is from 0·086 to 0·116 per cent. These are the percentages for normal health. Stomach troubles, that although only temporary and are frequently relieved by vomiting, reduce the blood sugar to amounts below these figures. To see whether these concentrations could be varied by alterations in the diet, the children were fed on one particularly rich in fat, but containing the same amount of carbohydrate. This was found to make no difference in the blood sugar concentration.

Books Received.

On the Chemistry of the Ancient Assyrians. By R. Campbell Thompson, M.A., D.Litt., F.S.A. (Luzac & Co. 25*s*.).

Mercury-Arc Rectifiers and Mercury-Vapour Lamps. By J. A. Fleming, M.A., D.Sc., F.R.S. (Sir Isaac Pitman & Sons Ltd. 6*s*. net).

Food and Health. By R. H. A. Plimmer, D.Sc. (Lond.) and Violet G. Plimmer. (Longmans, Green & Co. Paper cover, 2*s*. Cloth cover, 3*s*. 6*d*. Food chart 3*d*.).

Experiments in Genetics. By Charles Chamberlain Hurst, Ph.D. (Cantab.), F.L.S. (Cambridge University Press. 50*s*. net).

Forum. August 1925. Vol. LXXIV. No. 2. (Forum Publishing Co. 35*c*. a copy. $4 a year. Foreign $4.50).

Poetry. Vol. 8. No. 73. July-August, 1925. (Merton Press Ltd. 1*s*. monthly).

Armours and Weapons in the Middle Ages. By Charles H. Ashdown. (George G. Harrap & Co. 7*s*. 6*d*. net).

Geometry for Beginners. By J. G. Bradshaw. (Longmans, Green & Co. 2*s*. 6*d*.).

Talks about Wireless. By Sir Oliver Lodge. (Cassell & Co. Ltd. 5*s*. net).

General Zoology. By H. L. Wieman. (McGraw-Hill Publishing Co. 15*s*.).

Bacteriology. By Stanley Thomas. (McGraw-Hill Publishing Co. 12*s*. 6*d*.).

Journal of The Royal Anthropological Institute. (The Institute. 15*s*. net).

Scientific Paradoxes and Problems. By A. S. E. Ackermann, B.Sc. (Old Westminster Press. 5*s*. net).

The Evolution of Anatomy. By Charles Singer, M.A., M.D., D.Litt., F.S.A. (Kegan Paul. 12*s*. 6*d*. net).

The Fighting Rationalist. By W. Margrie. (Watts & Co. 6*d*. net).

Periodical Publications : Currently displayed in the Coventry Public Libraries. Compiled by Lydia A. Beasley. (Public Libraries Committee).

Witchcraft and the Black Art. By J. W. Wickwar. (Herbert Jenkins, Ltd. 8*s*. 6*d*.).

A Handbook to the Cases illustrating Simple Means of Travel and Transport by Land and Water. (London County Council. 6*d*.).

Introduction to Plant Anatomy. By Arthur J. Eames and Laurence H. MacDaniels. (McGraw-Hill Publishing Co. 17*s*. 6*d*.).

Principles of Genetics. By Edmund W. Sinnott and L. C. Dunn. (McGraw-Hill Publishing Co. 17*s*. 6*d*.).

Electrical Engineers Data Books. Vol. II : "Manufacture, Design and Laboratory Work." Vol. III : "Radio Engineering." Edited by E. B. Wedmore, M.I.E.E., F.Inst.P., etc. (Ernest Benn Ltd. 15*s*. net each).

Psyche. By Erwin Rohde. (Kegan Paul. 25*s*. net).

Art and the Unconscious. By John M. Thorburn, M.A., B.Sc. (Edin.), B.A. (Lond.) (Kegan Paul. 10*s*. 6*d*. net).

John Winthrop, Original Fellow of the Royal Society of London.

By T. E. James.

Very little has been known before about the connection between the first Governor of Connecticut and Agent to the Court of Charles II and the Royal Society. Mr. James' researches reveal a long maintained association, and throw new light on one of the important men in American Colonial history.

"Finding quaint wisdom in old volumes rare."

THE life story of John Winthrop, eldest son of the great leader of the Puritan emigration to Massachusetts and first governor of that colony, has been so fashioned as to embrace most aspects of his notable career. Yet there still remains something to tell concerning the scientific inclinations of the man, and his association with famous contemporaries of like mind and vision. Our design is to indicate, more definitely than has been done hitherto, Winthrop's connection with the Royal Society of London, of which he was an original fellow, and to show the method of his collaboration with the select circle of philosophers meeting at Gresham College in the City of London, the progenitors of "The Royal Society for the Improvement of Natural Knowledge."

JOHN WINTHROP, F.R.S.
(1606-1676.)
Governor of Connecticut. Agent to the Court of Charles II. Eldest son of John Winthrop, Leader of the Great Puritan Emigration to Massachusetts and Founder of the city of Boston.
(From the original portrait in the possession of Mrs. Robert Winthrop, of New York, by courtesy of Frederic Winthrop, Esq.).

Life.

Born at Groton Manor, Suffolk, in 1606, John Winthrop was educated at Bury St. Edmunds Grammar School and Trinity College, Dublin. Admitted at the Inner Temple, for a time he practised law, but left it for good and all in favour of travel and adventure. On June 27, 1627, Winthrop sailed from Portsmouth, a member of the Duke of Buckingham's naval expedition for the relief of the French Protestants at Rochelle. Its failure and disbandment brought him back to London before the year was out. He resided in the "Old Baylye," and had also a venue in Fleet Street, "neare the Conduit." In June, 1628 (the year in which the Duke of Buckingham, his former chief, was assassinated), Winthrop left England for a tour in Europe and the East.

Voyages.

Having finally cast the die for life in New England, Winthrop sailed in the *Lyon* for Boston, in August, 1631. He had married a few months before sailing, to wit, on February 8, and at the old Groton home. We learn that "there came in the *Lyon* the Governour's wife (*i.e.*, of Winthrop the elder) . . . and others of his children, and Mr. Eliot, a minister, and other families, being in all about sixty persons, having been ten weeks at sea." The "Mr. Eliot" alluded to as a fellow passenger was none other, in point of fact, than the Rev. John Eliot, known subsequently as the Apostle of the Indians, and famed for his translation of the Bible into their dialect. We shall presently see that this early connection of Winthrop with Eliot led to associations of singular and even romantic interest for the Royal Society of London. Established in New England, Winthrop in 1657 became governor of the colony.

Winthrop engaged in friendly correspondence in the old country with Sir Kenelme Digby and the Hon. Robert Boyle, both of whom were in close touch before, and at the Restoration in 1660, with the group of philosophers interested in the initial steps of the rise and progress of the Royal Society. It was an all-important influence. Letters extant show that Winthrop was in deep sympathy with the academical studies, philosophical inquiries and schemes of experiment fostered by the English circle.

Admission as a Fellow.

In the course of 1661 Winthrop was chosen as agent of Connecticut to the Court of Charles II, with the object of procuring a royal charter to consolidate various early privileges.* This mission afforded the rare chance at an eventful period in the history of the Royal Society of furthering Winthrop's scientific inclinations and of meeting with those old-time friends who knew his accomplishments and assemblage of learning. In anticipation of his voyage he made a will. It was dated July 12, 1661. This document opens with the words, " I being at present . . . in good health of body yet intending (if God please) to make a voyage over the seas into Europe. . . ." William Brereton** writing to Winthrop from Cheshire, on October 2, 1661, says, " I was very glad to find . . . that you were come to London and that you intend to make some stay in England. I hope to be at London within this fortnight and that I shall have the good hap to meet with you. I now say no more but that I hope an acquaintance begun at so great a distance will not be broken off when I shall be so happy as to see you." Winthrop seems to have had quarters " next to the Church in Colman Street." Soon we find him among his friends at Gresham College.

It is recorded in the Royal Society's first journal book, under date December 18, 1661, that " John Winthrop, Esq., was proposed as a candidate by Mr. Brereton." Again, at a meeting held on January 1 following, we read that " Mr. Winthrop was admitted into the Society." Christopher Wren, Dr. Wilkins, Dr. Croone and Sir Robert Paston were present, among others. Parenthetically, it may be added that Wren was to draw up a scheme for a weather-cock against the next assembly; also to prosecute his design of trying, by several round pasteboards, their velocity in falling. This first journal book opens with three foolscap pages, each dated at the head, December 5, 1660, and bearing the autograph signatures of 115 persons as constituting membership of a projected society for which the king's approval had been sought and obtained. Sir Robert Moray was elected president of the " Company." Each page (we may conjecture that in original form the pages were single sheets, but afterwards bound in), bore at the top, beneath the date, an obligation or form of adherence. On the second sheet of this historic record appears the signature of *John Winthrop*. The Royal Society did not, it should be observed, enter on corporate existence until July 15, 1662. Before then, however, as we have seen, Winthrop had qualified for admission, and in such manner as shown did he really become an original fellow of the society. It is interesting to note that Sir Peter Wyche, when signing on the same sheet as Winthrop, added to his signature in minute characters, " Ap. 2, '62," indicating thus the precise date when subscribing an obligatory document actually headed 1660. Attention has not hitherto been directed to this interesting fact and instance of carefulness. It supplies incontestable evidence that the second sheet bears some signatures of later date than the heading December 5, 1660, would itself imply and, indeed, has been hitherto accepted as implying. At the foot of the *first* sheet, in the bottom left-hand corner, are three or four lines of memoranda, mere notes—apparently made by the amanuensis—but scratched through with a pen almost to obliterate them, as being of no final importance. With a magnifying glass it can be seen distinctly that one line reads " December 12, J. Winthrop." We suggest that originally this was a form of reminder that Winthrop should be asked to sign his name whenever he presented himself. He was, of course, expected. It is a pleasing privilege to put on record this new Winthrop reference. When Winthrop was introduced to the Gresham College meetings, he would naturally be invited to attest adherence on the only roll as yet existing. The charter book (opened with the autograph of Charles II), not being ready until the close of 1664, Winthrop's name does not appear therein; he had returned to New England.

Moray's Influence.

We do not know, it is true, who took John Winthrop to Gresham College, but may we not hazard that it was Sir Robert Moray? That courtier was in high favour with the king, and was indeed primarily responsible for interesting his majesty in the " designe " or work of the philosophers; moreover, it was Moray who, on October 16, 1661, brought word " that hee and Sir Paul Neile kissed the king's hands in the

* The charter was obtained on April 23, 1662—St. George's Day.

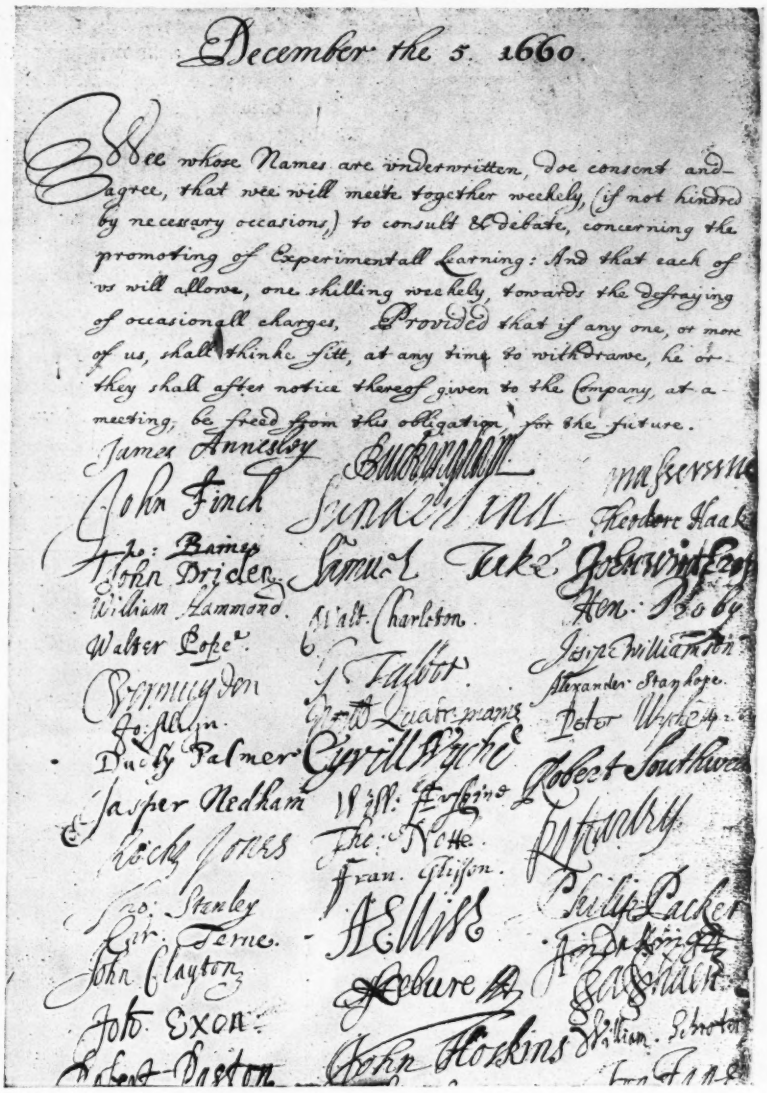
** Afterwards Lord Brereton.

Company's Name." When, on July 15, 1662, the Great Seal was affixed to a charter, the Royal Society became a national body.

John Eliot.

The president (Lord Brouncker) with the council and others of the society waited on the king on August 29, 1662, to thank him; and they kissed his hand. Why not surmise that John Winthrop was of the throng? He had been admitted. Tradition, indeed, held how useful he had been to the promoters. Sir Hans Sloane and others were responsible in 1733 for a certificate of recommendation into the society of Winthrop's grandson. They stated that he was "grandson of the Learned John Winthrop, Esq., who was one of the first members of this Society, and who, in conjunction with others, did greatly contribute to the obtaining our Charter." Winthrop himself, in a letter to Oldenburg, dated November 12, 1668, recalls his fellowship, saying that it was impossible to forget the happiness of his station when "for that short time I was in London they were pleased to permitt me to wait upon them at Gresham College."

Reference should be made now to John Eliot, the companion, as already mentioned, of Winthrop in the *Lyon's* voyage to New England in 1631. Eliot never returned to England. Born in 1604, he died at Roxbury, New England, on May 20, 1690, aged 86, and was buried there. Winsor ("*History of America*") states that Eliot was "imbued with the enthusiasm of the time." His spiritual labours on behalf of the Massachusetts Indians culminated in the first translation of the entire Bible into the Algonquian tongue as a medium of gospelization. Robert Boyle was in frequent communication with him and, indeed, furnished substantial sums of money for the furtherance of his schemes. In a letter addressed to Boyle, July 7, 1688, Eliot commences thus:—"Right honourable, deep learned, abundantly charitable, and constant nursing father, Sir, I am drawing home, and am glad of an opportunity to take my leave of your honour with all thankfulness. . ."


December the 5. 1660.
Wee whose Names are vnderwritten, doe consent and agree, that wee will meete together weekely, (if not hindred by necessary occasions,) to consult & debate, concerning the promoting of Experimentall Learning: And that each of vs will allowe, one shilling weekely, towards the defraying of occasionall charges, Provided that if any one, or more of vs, shall thinke fitt, at any time to withdrawe, he or they shall after notice thereof given to the Company, at a meeting, be freed from this obligation for the future.
James Annesley
John Finch
Walter Pope
Jasper Needham
Dudley Palmer
Theodore Haak
Alexander Stanhope
Peter Wyche
Robert Southwell
Philip Packer
John Clayton
John Hoskins

THE OBLIGATION SIGNED BY JOHN WINTHROP AT GRESHAM COLLEGE.
(*Reproduced by permission of the Royal Society.*)

Gift Volumes.

Two copies of John Eliot's Indian Bible were sent to the Royal Society by Governor Winthrop from Boston in October, 1669. The society until recently possessed one of them, a first edition in quarto, printed by Samuel Green and Marmaduke Johnson at Cambridge (Mass.) 1661-1663. It was *unrecorded* by C. Evans in his "American Bibliography, 1639-1729,"

published in 1903. Not only the above, but also another treasure in early American literature, Eliot's translation into the Indian language of Richard Baxter's "A Call to the Unconverted," in octavo, was sent over at the same time to Winthrop, as a personal gift to the society. Printed similarly to Eliot's Bible, but dated 1664, *no other copy of this work is known to exist.*†

At this point it is advantageous to recall the reception by the Royal Society of "divers curiosities of Nature" and of these books. At a meeting held at Gresham College on February 10, 1669-70, record was made by Henry Oldenburg, the secretary, as subjoined:

> The Curator [Robert Hooke] being absent, the Company instead of Experiments was entertained with reading of some letters, and the view of divers curiosities of Nature sent partly out of New England by Mr. Winthrop, Governor of Connecticut, all directed to Mr. Oldenburg. The letter of Mr. Winthrop was dated at Boston in New England, October 4, 1669, and the curiosities accompanying it were the following:—
>
> (*a*) Three dwarf oaks, with cups of acorns in them, the acorns being fallen off, of which there were some found in the box, whereof two were given to Mr. Charles Howard, and one to Mr. Oldenburg for Mr. Evelyn, to plant them here, and two reserved for the repository.
>
> (*b*) Some walnuts, of which one was given to Mr. Charles Howard, and another to Mr. Evelyn, and the rest reserved for the repository.
>
> (*c*) Ten pieces of candle-wood, which being lighted burnt with a good flame, and were used by many planters instead of candles. They were split out of the knots of pitch-pine; and tar is made of such knots.
>
> (*d*) Some minerals of New England.
>
> (*e*) Three pods of silk-grass.
>
> (*f*) The matrices in which those shells are bred of which the Indians make their white wampam-peage, which is their money.††

The entry records further that:

> There came also with these curiosities—
>
> Two Bibles in the Indian tongue;
>
> Three Books of the Practice of Piety, translated into the Indian tongue;
>
> Two Astronomical Descriptions of the Comet of 1664;
>
> One book of Mr. Baxter's Call to the (Un)converted turned into the Indian language;
>
> One Indian Grammar.
>
> Of these, Mr. Oldenburg desired one copy of the Practice of Piety and one of the Description of the Comet, which was granted him. After the Company had viewed the Curiosities it was ordered "that Mr. Oldenburg should return Mr. Winthrop many thanks from the Society."

† On behalf of the Royal Society, Messrs. Sotheby & Co disposed of Baxter's "Call" and Eliot's "Indian Bible" at a sale of books held on May 4 last. The first was bought by Dr. Rosenbach at the high figure of £6,800; the second by Mr. Quaritch at £310.

†† Four boxes were sent oversea, containing "curiosities." We have made a selection from the list in view of limitations of space.

Writing on March 26 following, to Winthrop, acknowledging the gifts, Oldenburg says, "I was very careful in presenting all to the Royal Society. . . . His Majesty himself, hearing of some of the rarer things would see them, and accordingly . . . the dwarf oaks . . . the silken pods, the bags with little shells in them, were carried to Whitehall where the king saw them with no common satisfaction."‡

From the foregoing narration we can now see, perhaps, the exact nature of John Winthrop's initial association with the Royal Society, of which it is interesting to note he was the first American colonist to become a member.

In 1809, one Eliot, an original member of the Massachusetts Historical Society, published at Boston a short biographical dictionary containing an account of the first settlers in New England. Referring to John Winthrop, junior, he acclaims him as one of the greatest philosophers of the age, and states that "the great Mr. Boyle, Bishop Wilkins, with several other learned men, had proposed to leave England and establish a Society for promoting natural knowledge in the new colony of which Mr. Winthrop, their intimate friend and associate, was appointed Governor." Such men, he says, were too valuable to lose from Great Britain, and Charles II having taken them under his protection, the society was there established and obtained the title of the "Royal Society of London." This truly fantastic idea, without a shred of authority behind it, was, strangely enough, reiterated in 1881 by the Hollis Professor of Mathematics in Harvard University. The assertion found credence again in 1889 in an article by Dr. G. Brown Goode, published by the American Historical Association. May we not hope that the last has been heard of it?

Winthrop's Exhibits.

The attendances of John Winthrop at Gresham College, in alliance with many famous contemporaries, "to consult and debate concerning the promoting of experimental learning," may be seen from the annexed journal book extracts, set down in order of date.

> February 12, 1661-2.
>
> Mr. Winthrop promised to deliver in an account of strange tides at the next meeting.
>
> March 5, 1661-2.
>
> The account of the refining of gold was ordered to be brought in at the next meeting by Dr. Goddard, Dr. Whistler and Mr. Winthrop.

‡ They were shown to the King by Sir Robert Moray.

April 23, 1662.

Mr. Winthrop showed a tin lamp, called a bladder's lamp, burning high like a candle, continually feeding itself, of which a diagram was ordered to be made and registered. He also produced malleable mineral lead, and a piece of a rock of granite.

(*N.B.—This was the date of the Charter which Winthrop obtained from Charles II.*)

April 30, 1662.

Mr. Winthrop produced a little stone, of which one part was, as it came from the rock, of an amethyst colour, and the other after calcination of a flesh colour. He brought also a piece of wood called *Lignum colubrinum*, the taste of which is bitter.

June 25, 1662.

Mr. Boyle, President—Mr. Winthrop was desired to communicate in writing the manner of making pitch and tar.

July 9, 1662.

Sir Robert Moray, President—Mr. Winthrop read his history of the making of tar and pitch in New England; and was desired to prosecute it.

July 16, 1662.

Mr. Winthrop brought in an account "Of the manner of making tar and pitch in New England."

July 16, 1662.

Mr. Brereton was desired to bring in Mr. Winthrop's account of the making of pot-ashes.

September 17, 1662.

A paper about the improvement and planting of timber, brought in by Sir Robert Moray from the commissioners of his Majesty's Navy, was read, and referred to the consideration of Mr. Evelyn, Dr. Goddard, Dr. Merret, and Mr. Winthrop.

RICHARD BAXTER
(1615-1619).
(*From the portrait in Dr. Williams' Library, London.*)

September 24, 1662.

Mr. Winthrop read his paper concerning the conveniency of building of ships in some of the northern parts of America. Winthrop's introductory remarks may be cited:—"The honourable Society may be pleased to consider whether it may not be fit to propose to his Majesty, or his honourable commissioners for the Navy, the conveniency of building ships in some of the northern parts of America; there being several reasons, that may be propounded, as motives encouraging thereunto."

October 1, 1662.

Mr. Evelyn was desired to peruse the papers concerning the propagating of timber, brought in by Dr. Goddard, Dr. Merret and Mr. Winthrop, and to add what he had of his own, digesting the sum of all into one paper.

December 17, 1662.

Mr. Winthrop showing the Society some Indian corn, some grains of which were bluish, promised to give them in writing the history of ordering it in the West Indies. He showed also the tail of a rattle-snake which, he said, increased every year by one ring, whence the people concluded the age. Dr. Merret took it home with him to make some trial of the powder of it.

December 24, 1662.

Mr. Winthrop showed an earth, brought by him out of New England, which swam for about half an hour, and then sunk to the bottom.

December 31, 1662.

Mr. Winthrop delivered in an account of maiz or Indian corn, which was ordered to be registered.

January 14, 1662-3.

Mr. Winthrop observed that a ship built in New England was lately arrived here, and he was desired to bring in an account of the shape and size of it. He was likewise reminded of the Indian bread and malt.

February 18, 1662-3.

Mr. Winthrop was acquainted that Dr. Goddard would afford him the necessary accommodation for the brewing of beer out of bread of maiz.

March 4, 1662-3.

The brewing of beer of barley bread, and of wheaten bread, and of other kinds of grain, as buck-wheat, oats, etc., mixed together, was again recommended to Mr. Winthrop.

March 11, 1662-3.

Mr. Winthrop presented some bottles of beer brewed of maiz-bread, which was a pale, well-tasted, middle beer. He was desired to keep some of his liquor for a while, to see how it would bear age. Being asked what proportion of maiz there had been taken to the eight gallons of beer which was brewed, he said, about half a bushel.

March 18, 1662-3.

Mr. Winthrop, acquainting the Society with his intention of returning soon to New England, was desired to take with him a copy of the directions for seamen. The amanuensis was ordered to have the said copy ready for him against the next meeting; and the operator to have a dozen sounding leads, and three or four balls made against that time; as also the cylindrical vessel with valves to fetch up water from the bottom of the sea.

March 25, 1663.

Mr. Winthrop received a copy of the directions for seamen; and the operator was ordered to make ready for him, as soon as he could, those wooden balls and leads, for which he had orders before.

July 22, 1663.

"Mr. Winthrop's letter written from Boston to Mr. Oldenburg was read, giving an account of the trials made by him at sea with the instrument for sounding of depths without a line, and with the vessel for drawing water from the bottom of the sea, both which proved 'successless,' the former by reason of too much wind at the time of making soundings; the latter, on account of the leaking of the vessel."

October 27, 1670.

The Society opening this day their assemblies again, there was presented to them from Mr. Winthrop, of New England, three boxes, filled with curiosities of that country, specified in a letter of his to Mr. Oldenburg, dated at Boston, August 26, 1670.

March 23, 1670-1.

Mr. Oldenburg produced and read several letters sent to him from abroad. First two letters from Mr. Winthrop dated at Boston in New England; one addressed to the Lord Brereton, October 11, 1670, giving an account of the removing and overturning a hill in those parts. The other letter of Mr. Winthrop was written to Mr. Oldenburg of the same date containing an enumeration of several things sent by him to the Society for their repository, viz.:

1. A peculiar sort of shell-fish called in New England the horse-foot.
2. A feathered fly.
3. A humming-bird's nest with two eggs in it. §
4. Some shells and bullets and hardened clay found within that mountain which had been overturned.

December 7, 1671.

Mr. Oldenburg produced a present of curiosities sent by Mr. Winthrop to the Society from New England, together with a letter from Mr. Wait Winthrop, dated at Boston, October 17, 1671.

John Winthrop, F.R.S., died April 5, 1676, at Boston, where he was buried in the same tomb as his father.

§ "The Humming Bird's nest was shewed to his Majesty, who was as much pleased with it as the Society" (Oldenburg, April 11, 1671).

The Volvocinae.

By Sir Arthur E. Shipley, G.B.E., F.R.S.

Either animal or vegetable, the point is undecided, Volvocinae mark the point where sex and sexual cells begin to make their appearance. Volvox is a fairly common object to the microscopist, but besides being one of the most beautiful subjects for pond life exhibitions it affords a valuable object for study.

THERE is a curious family of aquatic organisms known as the *Volvocinae* which are especially interesting because we can trace in various members of the group the origin of sex and sexual cells, and the origin of multicellular organisms from unicellular. Botanists claim these organisms as plants, and there is this to be said from their point of view, that all of them contain chlorophyll and their nutrition is holophytic.

Animal or Vegetable.

Zoologists also claim them as animals, for chlorophyll occurs in some animals, though not many, further they form an extremely interesting series whose possible ancestry seems animal in its nature. The members of this group all occur in stagnant fresh water.

The simplest method of reproduction is to divide in two as *Amoeba* does, and when the nucleus of the Amoeba is divided in two we have a bicellular organism which soon splits into two unicellular organisms. In the slipper animalcule (*Paramoecium*) we have seen that two exactly similar protozoa will fuse together, exchange some of their protoplasm, separate again, and shortly after will reproduce by fission. But these two conjugative organisms are exactly alike. You cannot call one a male and one a female. But in the *Volvocinae* we find indications of sex. The simplest of these organisms now under consideration is known as *Pandorina*. It consists of sixteen cells surrounded by what is known as the colonial cyst or envelope (Fig. 1, *a*). Each cell bulges out on the surface so that the organism looks something like a mulberry enclosed in a transparent case. From the bulging side of the cell two flagella stick out which pierce the colonial wall. Each cell is shaped something like a cone, the apex being near the centre of the little colony. Each cell has a nucleus, a contractile vacuole, a small pigment spot or eye, and is surrounded by a membrane. It also contains a large green corpuscle in which the chlorophyll is confined. Instead of the cells living separately they live together, and there must be some sort of co-ordination between the separate cells, as the flagella beat in unison. If they did not, orderly progress through the stagnant water would be impossible.

Cell Division.

Pandorina reproduces in twc different ways. Each of the cells divides into two, then into four, and then into eight and then into sixteen similar cells. Each of the sixteen original mother cells now contains sixteen similar cells still enveloped in the colonial membrane (Fig. 1, *b*). This latter, however, softens and finally dissolves, and the new colonies now part company and each of the new sixteen cells develops a new

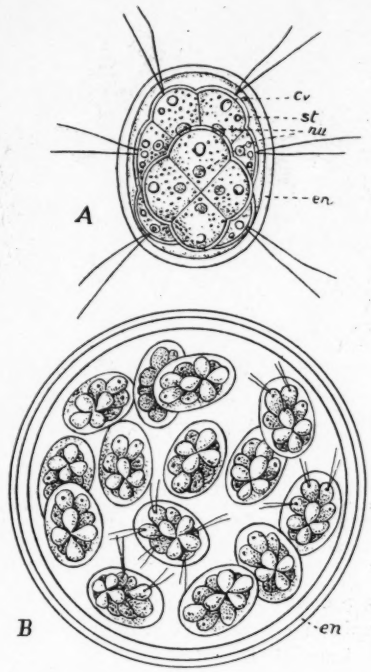


FIG. 1.
PANDORINA MORUM.
(*A*) A colony of sixteen flagellated cells, enclosed in a common colonial envelope. (*B*) A colony in which the cells have given rise by repeated binary division to daughter colonies, still enclosed in the common colonial envelope. (*cv*) Contractile vacuole. (*st*) Stigma. (*nu*) Nucleus. (*en*) Colonial envelope. (After Stein.)

envelope, and the whole develops a new colonial envelope.

This method of reproduction may go on for several generations, but sooner or later forms appear which must conjugate before they reproduce. In this stage the sixteen individuals of the colony divide into only eight cells. The mother colony sinks to the bottom, loses its flagella, and its colonial cyst as well as the original cell-cyst or envelope dissolves. This takes a little time, but ultimately the new colonies formed of eight cells are set free. Each cell develops two flagella and an envelope, and it escapes from the others and swims freely away seeking for a mate.

Formation of Zygote.

When it meets one both unite by their pointed ends and fuse together completely, forming what is called a zygote (a fertilized egg or ovum). For a time each retains its flagella, so that the zygote has two pairs. Presently it loses these and the zygote, still a single cell as the result of the fusion of two cells, forms a thick reddish wall round itself and enters upon a rest-cure. From this resting stage it will not emerge unless its surroundings have dried up and, of course, this only takes place when the pool of stagnant water in which it is living evaporates, generally during the hot summer months. When it rains the zygote shows signs of life again. Its envelope becomes thin and the zygote escapes as a naked cell which presently develops a new envelope and two flagella. It then divides into sixteen wedge-shaped cells with bulging bases and forms the colony first described above.

In *Pandorina* the two fusing cells (gametes, as they are called) are of the same size and appearance, there is here no trace of sex. But in some cases there are larger and smaller colonies, and the former produce large gametes and the smaller small gametes. If then the small gametes should conjugate or fuse with the large ones we have the first glimmerings of sex. The larger cell will be the macrogamete, the equivalent in the higher animals of the ovum. The small cell will be the microgamete, the equivalent of the spermatozoon or male cell.

Bi-sexual Eudorina.

Let us now turn our attention to a somewhat smaller organism, *Eudorina*, and we shall find in general structure that the normal creature resembles *Pandorina*; but there are some differences. It consists of thirty-two cells; but this is not a real difference between it and *Pandorina*, because *Pandorina* sometimes presents specimens which have thirty-two cells. These thirty-two cells of *Eudorina* are enveloped each in a cyst and the whole lot of them are enclosed in a colonial cyst, and through this cyst each cell puts out two pairs of flagella (Fig. 2). The cells,

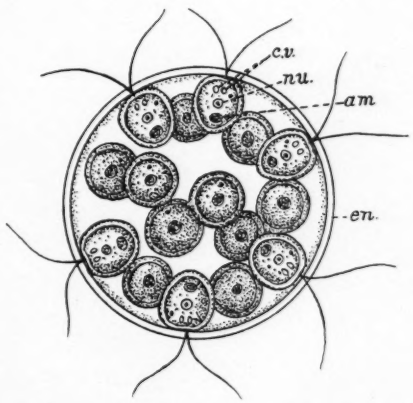


FIG. 2.
EUDORINA ELEGANS.
The colony consists of thirty-two flagellate cells, situated at some distance from one another, and enclosed in a common colonial envelope. (*cv*) Contractile vacuoles. (*nu*) Nucleus. (*am*) Amylum bodies. (*en*) Colonial envelope. (After Stein.)

however, are not necessarily in contact with one another. They are not cone-shaped, but spherical, and their inner ends do not reach the centre of the sphere. The whole organism is small, seldom measuring more than 0·1 or 0·15 mm. Each cell has in it a contractile vacuole, a nucleus, and a small pigment spot. Each of these cells now multiplies by dividing into thirty-two daughter cells just as happened in *Pandorina*. The colonial cyst then undergoes dissolution, and each little colony escapes to grow up to the size of the original organism. After doing this for several generations a form appears which has marked sexuality. Some of the colonies develop larger and more oval cells, the ova. In other colonies each cell will form a flat plate composed of sixteen or thirty-two cells which are coloured yellow. These are surrounded by a colonial cell wall and, after a time, each of them elongates, becomes torpedo-shaped and develops a pair of flagella which all point the same way. These are now definite male cells or micro gametes, and as soon as the plate has escaped from the parent envelope the whole plate, very much like a bundle of cigars, swims away to look for the macrogametes. These they find at rest, and as soon as they get near them the plate breaks up and the microgametes separate from one another and work their way through the colonial cyst of the now female colony and ultimately conjugate with the cells, two cells fusing together to form the zygote.

Here we have an example of cells, primarily alike before they divide up, producing male and female cells. But it will be noticed that all the cells can produce these sexual cells. In higher animals and plants this is not the case. A certain part of the body is set aside for their production, but the great mass of the body is occupied with other organs for feeding, breathing, moving, and so on. The part of the body minus the sexual cells is often referred to as the *soma*, and we get a glimmering of a *soma* in the little creature known as *Volvox*.

Volvox Globator.

Volvox is a whole sphere whose walls consist of a single layer of cells. One finds it commonly in ponds and ditches, revolving in a stately way through the still water, just as our globe revolves through space. Each of its cells is somewhat hexagonal in shape, as things are apt to be when there is mutual pressure (Fig. 3). The protoplasm of each cell does not fill up its envelope. *Volvox* is about double the size of *Eudorina*, measuring from 0·2 to 0·7 mm. From each of its cells—and there may be as many as 12,000—protrude a pair of cilia, and each cell again has

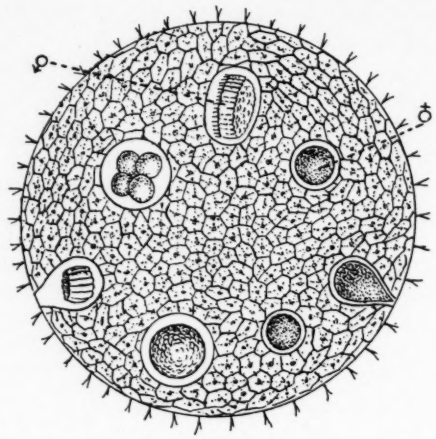


FIG. 3.
VOLVOX GLOBATOR.
(*A*) A sexually ripe colony, showing mocrogametes and macrogametes, in various stages of development. (*B*) A portion of the edge of the colony highly magnified, showing flagellate cells united by protoplasmic threads, and a single reproductive cell. (*rp*) St. stigma. (*cv*) Contractile vacuole. (After Kolliker.)

a nucleus, a contractile vacuole, and a pigment spot. The protoplasm of each cell is further connected with the protoplasm of the others by fine strands which pierce their envelope. There is, therefore, a certain physical continuity which no doubt aids in the co-ordinated lashings of the flagella, for were they unco-ordinated the smooth and even progress of the creature through the water would be impossible.

Specialised Cells.

Each of these cells with its hexagonal-shaped cyst can and does multiply by means of division, and in this way the body of the *Volvox* increases in size, but unlike the cells of *Pandorina* or of *Eudorina* these cells cannot, except in special cases, reproduce the whole colony. The nutritive cells die after a certain time: they form a mortal body—something to make a corpse of.

Volvox reproduces both sexually and asexually. If carefully watched it will be seen that some eight cells out of the many thousands that make up this revolving globe grow to a larger size than the others, and that these are further conspicuous by the absence of all flagella. These cells are capable of multiplying without any fertilization or conjugation. They gradually give rise to a small new colony which, when it has reached a certain period of growth, drops into the cavity of the mother and is seen lying within it like the ivory spheres of a Chinese puzzle lie one within the other. These cells being produced asexually are often known as *parthenogonidia*. More than one young colony may be in this gelatinous sphere of the

mother at one time, but ultimately the spherical layer of cells which forms the mother is ruptured and the young forms swim away "on their several occasions."

Parthenogonidia may be produced one generation after another, but sooner or later sexual reproduction will take its place. We then find certain of the ordinary cells become larger and form the potential ovum of the organism. Each cell loses its flagella, becomes dark green and projects towards the centre of the globe. This is the macrogamete, and unless it is fertilized it comes to nothing. There are some fifty of these cells. The microgametes or spermatozoa are also formed from large cells, and at first are indistinguishable from the female cells, but they split up into 128 small cells which lie in a plate something like a bundle of cigars tied up by a thin ribbon. But in time the ribbon bursts, the microgametes are set free, and these cigar-shaped little structures make their way through the central gelatine of the globe towards the macrogametes which are projecting into it. The two cells fuse and form a zygote. This will then rend itself off and form a thick shell or cyst of a red colour, and with many projections. Here again, as was the case with *Eudorina*, the *Volvox* does not develop unless it has undergone a period of desiccation or drying up. In this stage the winter is overpassed, and in the warm rains of the spring the zygote comes to active life again and develops into a normal *Volvox*.

Thus we have seen in *Pandorina* that the ordinary cell of the body is capable of conjugating with another cell of the body, but always of the same size. Here all the cells are both nutritive and reproductive. Similarly, in *Eudorina* we find almost the same takes place, but here we get a large cell being fertilized with a small cell, an ovum fused with a spermatozoon.

Chain of Transmission.

But in *Volvox* special cells are set apart for reproduction, and they and they alone can form new colonies. The other cells which take no part in reproduction are vegetative or nutritive cells. We thus meet here for the first time the typical male and female cells, and also for the first time the division of the body cells into cells which are reproductive and cells which are not. In all higher organisms this is the same, and there is a good deal of evidence that in the early stages of segmentation of the egg—*e.g.*, that of the domestic fly—various cells are set apart which will form the rudiment of the ovary or the testes, whilst the other cells remain nutritive. This reproductive protoplasm is believed to be handed from mother and father to offspring, and in their turn from these offspring to later offspring, so that each individual is, as it were, a bead strung on a strand of this protoplasm. The bead—the body—or *soma* is the individual, the strand is the reproductive plasm or germ plasm.

One of the curiosities of *Volvox* is that one frequently finds a small parasite living in its gelatinous interior. This is a rotifer known as *Proales parasita*. A certain —or rather uncertain—species of sporozoan parasite is also recorded from *Volvox*.

These little creatures, no bigger than a small pin's head, progress forward by the action of their cilia, and, advancing, like a planet they rotate either to the right or to the left, though the latter is more frequent by their choice than the former. Watching their majestic and inexorable progress through the water on the microscope slide under a low magnification, one is reminded of W. S. Gilbert's exhortation to the terrestrial globe:

Roll on, thou ball, roll on!
Through pathless realms of space
Roll on!
What though I'm in a sorry case?
What though I cannot meet my bills?
What though I suffer toothache's ills?
What though I swallow countless pills?
Never *you* mind!
Roll on!

WATERPROOF MATCHES.

If the recent invention of Mr. Morland M. Dessau is generally adopted, we shall in future be able to drop matches into water without spoiling them. No longer shall we shelter out of the rain whilst lighting pipe or cigarette; no more early morning profanity at finding the matches drenched by the geyser overflow. Mr. Dessau has waterproofed matches so that they can be, to all intents and purposes, hopelessly soaked and yet ignite upon striking on the box. This he has done by incorporating rubber latex with the fulminating material and vulcanising the completed match by the well-known Peachey Gassing Process.

LIGHT TRANSMISSION.

The property of light transmission by fused quartz rods has now been tested with a rod of twenty-six feet long, and the colour of the emergent light was unchanged. The property is not, however, entirely confined to quartz or pure silica and a rod of any fine glass, such as boro silicate opticai crown glass, exhibits the transmission in short lengths of a foot or more. The principle is now being used for microscope illuminators.

Railway Geology.

By W. F. F. Shearcroft, B.Sc., A.I.C.

The author advances some remarkable figures which have a direct bearing on man as a geological agent. The railways of the British Empire have required the shifting of thirty-nine thousand million cubic yards of material.

In a centenary year it is difficult to write a single sentence on railways that is not a well-worn one. It is highly probable that before 1925 is out we shall be tired of 1825! There is, however, one aspect of the past century's railway activity that will not receive its fair share of attention. The geological side is not so striking as that of the facilities and comfort of travel, but it is certainly of very great importance.

The railways have carved up the crust of the earth. Not content with scratching on the surface, they have dived beneath it and brought to light the raw materials on which the geologist bases his conclusions as to the history of the earth. In this way much valuable information has been gained; and a first step to the geological

THE DENUDATION BY STEEL AND STEAM.
A scene on the Canadian Pacific Railway.

Denudation Agents.

study of any area is an examination of the railway cuttings to be found in it. More striking still is the light that railway construction throws on man as a geological agent. We recognize that man is having a very marked effect on the appearance of the earth's crust, and here we are able to express this effect in figures that are staggering.

It will be obvious that the total effect will be included in that wearing down of the surface which we call denudation. The natural agents of denudation have been long recognized as being responsible for much of the appearance of the landscape. These forces have carved the mountains into valleys and hills, and have required vast ages in which to accomplish their task. Man likewise may be included in this category of forces of denudation, although we are apt to differentiate his work as artificial, and, as such, take little notice of it. A consideration of what a century of railway construction has accomplished in this way will lead to the conclusion that man's influence cannot be neglected.

A railway track is laid, as far as humanly possible, on level ground for very obvious reasons. Where man's directional desires do not coincide with natural plains, excavation has to be undertaken. The track itself needs a firm foundation, which also entails excavation. Figures are not easily got at in a convenient form, but they are available for what was the Great Central

Astonishing Figures.

Railway, which was the last British railway to be constructed. From a careful study of figures published for a distance of just over 106 miles of this track, Dr. Sherlock* concludes that, for every mile of track constructed, there is an accompaniment of excavation of 130,219 cubic yards of material.

*R. L. Sherlock, "Man as a Geological Agent."

We will round this figure off to 130,000 and use it in a wider estimate, in order to illustrate the immensity of the century's effect. Confining our attention to the British Empire we will attempt to gain a figure for the total mileage of railways that have been constructed. This is not so simple as would be imagined, as the published figures refer almost invariably to total mileage of service. Some of this will be single track, some double track, and for shorter distances there may be very many tracks side by side, as in the approaches to big termini. Then, seldom is reference made to sidings and goods yards. Search for details in this respect would be a very lengthy task, and as the figure taken above will have only a very rough general application to other areas, such accuracy would serve no useful purpose.

The total length of railways in Great Britain in 1909 was 23,272 miles, and when this is reduced to single track the total mileage becomes 38,872 miles. To this must be added 14,032 miles of sidings, making a grand total of 52,904 miles of single-track. In a small congested area such as Great Britain the proportion of side tracks to main lines would be higher than in countries of wide expanses. The single track mileage given above is about two and a quarter times the length of service track. If, in the calculations that follow, we use a factor of one and a half, we shall be on the safe side and avoid any possibility of exaggeration. The "Statesman's Year Book" lists 174,276 miles of railway service within the British Empire. This undoubtedly is a low figure, for only occasionally is any notice taken of privately owned railways, such as occur in big factories and mining areas. We can safely round it off to 180,000 miles. This gives us a total length of 270,000 miles of single track, and in view of the low factor used to get this, we may again use the round figure of 300,000 miles.

Comparative Statistics.

This means an excavation of 39,000,000,000 cubic yards of material in the construction of the railways of the British Empire. Such an imposing row of figures has very little meaning for any of us, but if we imagine this amount of material distributed over an area equal to that of England and Wales, we should obtain a layer about eight inches deep, or over the 117 square miles of the administrative County of London it would form a nice little hill just over 300 feet high.

We may look at it another way. Accepting the figure that every mile of railway needs fifteen acres of land, we may imagine all this matter excavated from the immediate fifteen acres of country adjacent to the railways. This means the removal of about fifty feet of matter from every mile of railway in the Empire, if we average out the total. We may halve this figure, and then compare it with the estimates of the geologists who are more or less agreed to assess the action of all forms of natural denudation, as opposed to that of man, as amounting to about a foot in eight thousand years!

Further Effects.

Of course wider consideration of man's total effect, as an agent of denudation, reveals compensating influences, where what is destroyed is balanced by what is made, but even then we cannot but be impressed by the huge effect. We have further to recognize that almost all this railway excavation has been done in the past century. If it were continued in the future, at the rate of the past, it would soon constitute a problem requiring very serious attention. This activity seems, however, to possess the universal characteristic of man's efforts—namely, it is intermittent. The burst of railway enthusiasm has reached and passed its climax. All future plans will be designed with one eye on the possibilities of transit by air, and there is little doubt that the next century will see comparatively little extension of present mileage.

The aspect of railway work that we have considered will very likely be another unique one in a century of unique progress.

PAST CLIMATES AND CONTINENTAL DRIFT

(*Continued from page* 367).

crust, while liquefaction and consequent expansion will produce tension, and therefore splits and rifts in the continental masses; and further, these, once the underlying basalt is liquefied, must "wander" under the influence of tidal forces.

Here, then, we have the conditions for Wegener's moving continents; however, the conditions are not permanent, but recur cyclically. Thus we should not be surprised if we do not now find the westward movement of America postulated by Wegener, since the continents may at the moment have been "frozen in," like a ship in the Arctic—reduced to immobility by the solidification of the medium which supports them.

Enough will, I hope, have been said to show the interest of the vigorous young science of geophysics, and of the numerous problems so boldly attacked by Wegener. Whether he prove right or wrong, our thanks are due to him for having here collected such a store of facts, and still more for drawing the attention of science to such important and fascinating problems. It is, however, extremely unfortunate that a book of this compilatory type should be issued without an index.

Book Reviews.

Electrical Engineer's Data Books. Edited by E. B. WEDMORE, M.I.E.E. Vol II.: "Manufacture, Design and Laboratory Work."; Vol. III.: "Radio Engineering." (E. Benn Ltd. 15*s.* net per volume).

The research student and the practical engineer both know the extreme difficulty of keeping abreast or in touch with the latest developments of research in any particular branch of knowledge. Records of important work which may at the moment have no practical application are buried in sparse publications or indexed under inappropriate titles. All too often valuable work appears in foreign publications which are difficult of access and not always in a language known to the inquirer. In these cases there is a tendency to fall back on the "pocket book" type of potted information, and it is also noticeable that the "pocket book" available in the average office may be anything to a decade or so out-of-date.

Mr. Wedmore, Director of the British Electrical and Allied Industries Research Association, has tackled this difficulty of bridging the gulf between abstracts and research work in general, and the practical application of this knowledge by compiling a new form of book. These engineering data books are not simply abridged and tabulated information like conventional "pocket books," but contain general summaries of all the essential facts and theories as well. They are ideal books for the scientist and the physicist who wishes to design special apparatus, for they are a perfect bridge between the mechanical and the scientific side. The student will find them of greater value than a shelf of specialized textbooks, and they are thorough to an astonishing degree. One little point alone indicates this. They include a table of the Greek alphabet, so that the engineer educated almost certainly on the modern side may not be discomfited by some unfamiliar symbol in one of those complex formulae which exhaust the normal range of symbolism.

Essentially practical, they are yet the last word in electrical reference books and represent the best possible value for money.

Roman Folkestone: A Record of Excavation of Roman Villas at East Wear Bay, with Speculations and Historical Sketches of Related Subjects. By S. E. WINBOLT, M.A. (London: Methuen N.D. pp. xiv, 199, with 21 plates, illustrations, and end paper. Price 8*s.* 6*d.* net).

Archæological excavation can be as exciting as any treasure hunt, and in the long run may be more beneficial to the excavator; and if the author avoids the more obvious pitfalls of unnecessary detail, the story of a "dig" on a productive site can provide as many thrills as the average novel of adventure. Mr. Winbolt has a feeling for the fascination of his work, and has tried to convey it to his readers by devoting two chapters of his book to a day-to-day record of his excavations. Here it is possible to follow the process of gradually uncovering the remains, of tracing the walls, and slowly working out the plan of the buildings, and what is even more interesting, the reader may accompany the author in the gradual realization, through conjecture after conjecture, of the nature and purpose of the structure which was being brought to light.

Readers of DISCOVERY have already been made familiar by the author himself with the circumstances which led to the discovery of these villas at Folkestone. The finding of urns belonging to a British burial of the late Iron Age, made it clear that the site had been occupied in Pre-Roman times, and Mr. Winbolt is of the opinion that this early structure had been adapted and enlarged by the Romans. Originally his opinion was that it was a look-out station; but as the excavation proceeded it became clear that he had discovered an important residential site, the only one known to exist on this part of the coast. The importance of its position led him to conclude that it was the official residence of a naval commander of high rank, a conclusion which was confirmed by the discovery of seven tiles bearing the inscription *Clasis Britannica* (note the spelling *clasis* for *classis*) or its usual variants. The objects found on the site, and in particular the coins, suggest that the Roman occupation began soon after A.D. 81, and ended sometime soon after A.D. 353.

The chapters on related subjects serve to give the reader who is unfamiliar with Romano-British archæology an idea of the background of the discovery, while the more detailed chapters dealing with the various classes of finds make it possible for the uninitiated to grasp the methods of the archæologist in working out his results. Mr. Winbolt's book, however, is no mere popular and ephemeral work. His careful and detailed account both of the excavation and the finds make it indispensable to the specialist in Romano-British studies.

Varia: A Miscellany of Verse and Prose, Ancient and Modern. By ELEANOR M. BROUGHAM. (Heinemann. 8*s.* 6*d.* net).

Here is a gathering which is entirely and unscrupulously mixed—but perfectly delightful. Epitaphs, minor poems and odd scraps of letters build up a quaint but human picture of bygone days. A shrewdish letter from Elizabeth to Mary Queen of Scots confronts a pious and patriotic prayer in praise of the former. There is one particular saying of Robert Leighton (1611-1684), which will appeal with particular pungency to readers of DISCOVERY: "Deliver me, O Lord, from the errors of wise men, yea, and of good men." It might be well adopted in America now. To anthropologists the following will have a particular appeal:—

Here lies the body of William Jones
Who all his life collected bones
Till death, that grim and boney spectre
That universal bone collector,
Boned old Jones, so neat and tidy,
And here he lies—all *bona fide*.

Oscillographs. By J. T. IRWIN, M.I.E.E. (Pitman. 7*s.* 6*d.* net).

Students will welcome this little book as a comprehensive guide to the theory construction and use of all types of oscillograph. It includes the cathode ray oscillograph, an instrument of increasing importance for physical laboratory work. It is a technical manual of considerable value, and gives a good general idea of a subject of considerable complexity not usually found in even advanced textbooks.

The Mind and its Place in Nature. By C. D. BROAD, M.A., Litt.D. (Kegan Paul. 16*s.* net).

This is one of the most important books which have appeared for a long time. It is important not only because it is a remarkable survey of the whole field of psychology and philosophy, but because it is a hard-headed, hard-hitting scientifically reasoned work; a piece of brilliant surgery. The

layman too busy to do more than dip here and there into the welter of confused theories will find here solid meat and sound guidance, a handbook to fallacies, an acid test of the specious but unsound. The appeal lies not only in the quality of reasoning, which is rather that of the scientist than the crossword puzzles of the meta-physician, but also in the quality of the work itself. It is dry and invigorating, "*goût Anglais.*"

The whole panoply of psychology from the traditional views of mechanism and vitalism, our knowledge or lack of knowledge of matter, our own and other minds are critically surveyed and then à bold excursion is made into the question of human survival after death. The pith of the whole survey is embodied in a few pages on the Status and Prospects of Mind which close the volume. "Now the greater part of the mind's knowledge and control over inorganic matter is quite new. It dates from the time of Galileo and Newton. Such as it is it has been gained under the most unfavourable circumstances by the work of a comparatively small group of men, surrounded, influenced, and often opposed by a majority whose minds are warped by the superstitions and heated by the emotions of patriotism and religion." . . . "and when we remember how quick and cumulative has been the growth of our control over inorganic matter since Newton's time, we need not despair of a similar growth of control over living organisms. We must remember, however, that, even if we had enough knowledge of biology, physiology and genetics to produce healthier bodies and better and better brains, there might be insuperable *psychological* difficulties in applying it." . . . The beginnings of a genuine science of organisms exist, and progress in this science might at any moment become rapid. Suppose that Europe does not relapse into barbarism before America has emerged from it, it is quite possible that the next two hundred years may witness as great an advance in our knowledge of living matter as the last two hundred years witnessed in our knowledge of inorganic matter. But so far as I can see, there are not even the beginnings of a scientific psychology of the individual or of communities. And, unless this defect can be remedied, there seems to be no hope either of devising a stable yet progressive social system, or of making the vast alterations in men's minds which would be necessary before they could work such a system and live happily in it." . . . "Now undoubtedly the greatest immediate threat to the further progress of the human mind is the *unequal development* of these three branches of knowledge; *i.e.*, the relatively high degree of our control over inorganic nature, combined with our still very rudimentary knowledge of biology and genetics, and with the complete absence of a scientific psychology and sociology." . . . "But physics and death have a long start over psychology and life."

The Earth Speaks to Bryan. By HENRY FAIRFIELD OSBORN, LL.D., Research Professor of Zoology, Columbia University; President, American Museum of Natural History. (Charles Scribners. 5*s.* net).

The death of Bryan has robbed us of one of the great mouthpieces of the Tennessee trial, but it has left the main issue untouched. In this book Dr. Osborn, one of the outstanding men of science in the United States, joins conflict with the Fundamentalists in support of the theory of evolution. The book is strange to English eyes in that much of it is a restatement and justification of the normal attitude of the educated man toward science and religion. It can be recommended to Protestant Christians who accept the Old Testament as an infallible source of natural as well as spiritual knowledge.

Abrams' Methods of Diagnosis and Treatment. Edited by SIR JAMES BARR, C.B.E., D.L., F.R.S.E., F.R.C.P. (Heinemann. 5*s.* net).

The Abrams' oscilloclast machine has provided one of the bitterest controversies in recent medical annals. There is now a considerable bulk of medical testimony to the effect that in some cases a wide range of cures have been made and that these cures are apparently due to the treatment. Nevertheless, the supporters of the system cannot produce any logical scientific reason why this apparently illogical and redundant collection of electrical gadgets should have any effect at all. Those hostile to the affair claim that the whole effect is due to accident, suggestion, or the law of chance.

Sir James Barr champions Abrams, and in a vigorous introduction does much to rehabilitate his character. The book then proceeds to an outline description of Abram's theory that dried blood emits an emanation which is variable and which, when submitted to a certain electrical stimulus, causes definite and detectable reactions in the body of a normal human appropriately connected to the specimen. The book gives little detail of these changes which are alterations in the percussion value of certain areas of the body of the human being acting as a detector in the test. A series of interesting case records and a report on the electrical effects of the apparatus by a physicist conclude the volume.

It would seem that if the Abram's method of diagnosis and treatment is as effective as reported, no special knowledge is required. Great play is made of the fact that the members of the Electronic Society of London are medically qualified, but if the machine is the miracle worker it is contended to be, then it is something which is so far ahead of medical knowledge, and so purely mechanical in its functions, that a good piano tuner or anyone with a training in percussion should be able to work it as well as the highest qualified professional medical man. The apparatus, a healthy tester, a man of the spots, and a pamphlet showing what resistance plug is believed to be best for a particular spot or patch reaction is all that is seemingly needed. We acknowledge the professional rectitude of this attitude of the electronic practitioners, but if their claim is correct, and the Abram's machine mechanically or rather electrically accomplished cures more or less as a repetition lathe turns out bits of machinery with the minimum of intelligent supervision, and these cures are inexplicable in the light of medical knowledge, it seems unreasonable to expect the public to pay for medical knowledge not supplied.

The book may be taken as a statement that a certain number of qualified medical men still believe in the system, but are no nearer to explaining it. In point of fact, many accepted medical applications of electricity are of dubious value, and even the fitting of a satisfactory theory to explain a series of cures does not always stand scientific as distinct from medical criticism. It is in accordance with human psychology and the laws of hazard that any apparatus, however odd, will produce some cures. On the other hand, there appears to be adequate basis in the Abrams' effects for further investigation. This should be done by a mixed committee of physicists and medical research workers. The public want scientific fact rather than opinion.

Evolution, Heredity and Variation. By D. WARD CUTLER, M.A., F.L.S. (Christophers. 4*s.* net).

A simple handbook which aims at expressing the development of modern theories and the lines on which biologists are working to-day. Sex inheritance, variation, and biometry, are outlined and current theories and accepted results considered.

Journal of the Royal Anthropological Institute. Vol. LV, 1925. (Published by the Institute. 15*s.* net).

This journal, which is a substantial book, should be more widely known and circulated, for it is one of the most wonderful records of the little known peoples of the Empire and their predecessors. The present number includes the presidential address on little known tribes of the Southern Sudan, a Flint Chipping Floor at Aberystwyth, three articles on Australia, and an excellent study of the African throwing knife, which is of value not only to anthropologists but also to collectors of weapons. South Africa is represented by an article on the Boshop Calvaria, and the Mother Country again by the record of the Excavations at Creswell Crags.

The scope of the journal is not necessarily limited to the Empire, and an article on the antiquities found at Katanda, Altai; nevertheless, the journal is of great importance to the overseas Briton who has first-hand opportunity of observing native races and doing useful work.

Armour and Weapons in the Middle Ages. By CHARLES H. ASHDOWN. (Harrap. 7*s.* 6*d.* net).

Nearly all genuine armour of importance is in the hands of national museums or private collectors. An even greater amount of replica or forged armour is to be found in the hands of private collectors, and it is a matter of common gossip that one semi-private museum connected with an important commercial concern has for some years been buying up imitation armour at auction sales. They do not exhibit this peculiar collection in their museum, and why they buy it is rather a mystery.

This little book by the late Charles Ashdown is useful, for it fills the need for a simple yet orthodox book to which the costume artist or the cinematograph producer can turn for guidance. It is, however, of little value to the collector or the expert, and is admittedly written for the uninformed visitor to museums and the man-in-the-street. The title is misleading, in that although the book goes to "1600 and after," a few sentences alone are devoted to firearms. These weapons alone changed history in the sixteenth century and without them the great story of the conquest of the New World and even the sea fight of the Spanish Armada might have been different. The work therefore cannot be accepted as giving a truly historical standpoint, and suffers badly from this lack of proportion. Certain pieces of armour, notably the brayette, are not even mentioned, and incredible as it may seem, that feature of the Elizabethan age, the rapier, is not to be found in the index. C. B.

Witchcraft and the Black Art. By J. W. WICKWAR. (Herbert Jenkins. 8*s.* 6*d.* net).

From time to time we have had books about witches and witchcraft, which were in the main a re-hash of the old seventeenth century tracts and pamphlets. Mr. Wickwar approaches the subject from the point of view of folklore and introduces a limited amount of psychology. He, wisely, does not attempt to bring the full orchestra of Freud to bear in a work which is essentially popular, but he suggests fairly obvious lines of thought to the student of psychology. These points are customarily missed by the historian, and witchcraft interpreted from this modern angle becomes far more understandable.

In the main British witches are dealt with, and few excursions are made into Continental varieties with the exception of a short section on werwolves and lycanthropy. The author in a necessarily short survey confines himself to what one may call the historic survey of British witchcraft and has made no attempt to deal with the inverse arcana and the black mass during the last two centuries and in the present day. These belong to the dark shadows of occultism rather than to the half-world of our rustic witches, yet it is among these that he will find the higher ranks of that curious hierarchy whose adepts mastered and inspired these lowly circles.

Witches are still with us to-day. In Devon they charm warts and even defy the mechanical separator of the modern dairy wench with the evil eye. The effect of the latter is in practice curiously like the administration of a little rennet. Cold-blooded science suggests a little rule of thumb bacteriology as a solution. In Ireland the savage natives still believe in the darkest of witchcraft. They sat a reputed witch upon a fire in 1910, and it is a far more common source of tragedy than appears in the papers. In the far West the slave tribes of Mayo still dress their boys in shirts until they attain puberty in order that the "good people," a euphemism for bad spirits, should not overlook them. The book may be heartily recommended for both the casual reader and the student of historical bypaths as indicating the outlines of an intelligent modern study of an interesting subject.

Bacteriology. By STANLEY THOMAS, M.S., M.A., Associate Professor of Bacteriology, Lehigh University. (McGraw Hill Publishing Co. 12*s.* 6*d.* net).

Bacteriology is a subject of annually increasing application. It is no longer simply the province of the pathologist, but takes its place as one of the fundamental sections of scientific training needed in many industries. This aspect is perhaps more clearly recognised in the United States than in Great Britain, and books embodying a comprehensive introduction to the study of bacteria as a whole are beginning to take an important place in non-medical scientific training.

Professor Thomas has produced an admirable general survey of a subject which is, as a rule, limited to the specialist. The book is not essentially a textbook and includes no laboratory practice, but it is a very comprehensive account of the fundamentals of this branch of science. The application of bacteriology in water engineering, food and hide preparation, and kindred industrial uses are outlined, and the earlier chapters give a good historical outline, and the standard of classification adopted in the U.S.A. The later chapters introduce the bacterial enzymes and Emlicus sidechain theory, and the preparation of vaccines are discussed under the heading of immunity.

The book is concise, well documented and up-to-date, but might have been strengthened by a bibliography dealing with particular applications. It is particularly suited to moderately advanced students requiring a general introduction to the subject, and is not too technical to be beyond the grasp of the general educated reader. J. McC.

A Flying Visit to the Middle East. By SIR SAMUEL HOARE, Secretary of State for Air. (Cambridge University Press. 3*s.* 6*d.* net).

This little record of a Cabinet Minister's journey through the hot air regions of Palestine, Trans Jordania, and Irak, will be read with enthusiasm by schoolboys and adults with the requisite political sympathies. The binding is in excellent taste.